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# GUIDELINES FOR IMPLEMENTING NATURAL RESOURCE INFORMATION SYSTEMS: THE RIVER REACH FISHERIES INFORMATION SYSTEM

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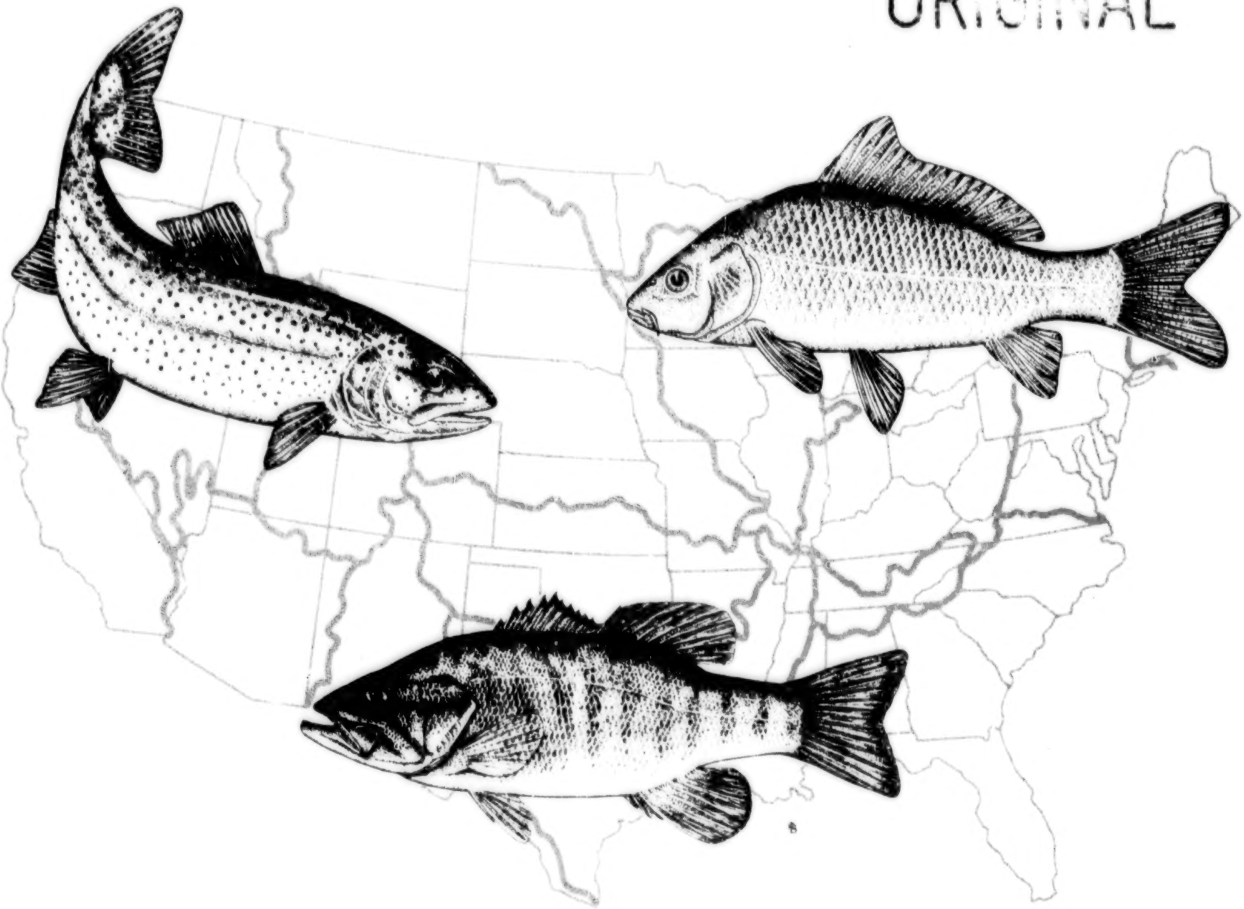

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May 1985

# GUIDELINES FOR IMPLEMENTING NATURAL RESOURCE INFORMATION SYSTEMS: THE RIVER REACH FISHERIES INFORMATION SYSTEM

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# PREFACE

The U.S. Fish and Wildlife Service (FWS) Western Energy and Land Use Team's (WELUT) Wetland Ecology Group developed the River Reach Fisheries Information System (RRFIS) primarily for use in fishery and aquatic habitat management; it has also been integrated successfully into broader management planning efforts. The System has potential utility for wetland planning and management. Although the structure of the RRFIS is very flexible, the software system currently used is highly specialized and, therefore, the software is maintained and operated by the FWS. It currently is operational and supported on CDC mainframe computers. Users cannot be assured of the same quality of performance or be provided accurate costs for use of this data base with other available hardware and software.

While this document serves to introduce the potential user to RRFIS, and provides a step-by-step guide to implementation, interested parties are encouraged to contact the FWS for further information before proceeding with data base development. Please contact the

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## CONTENTS

Page

PREFACE ........ iii
ACKNOWLEDGMENTS ........ vi

INTRODUCTION ........ 1
    Development of the RRFIS ........ 2
    Applications of the RRFIS as a Management Tool: Development and Testing ........ 6
DESIGN AND CONCEPT OF THE RRFIS ........ 7
IMPLEMENTATION OF THE RRFIS ........ 10
    Steering Committee ........ 10
    Choosing the Computer Environment ........ 11
BUILDING THE RRFIS ........ 13
    Step 1: Structure and Function ........ 13
    Step 2: Geographic Coverage and Map Scale ........ 14
    Step 3: Updating and Numbering Reaches ........ 15
    Step 4: Map Digitizing and Plot Production ........ 16
    Step 5: Textual/Tabular Data Collection and Editing ........ 18
    Step 6: Computer Data Entry ........ 18
    Step 7: Formatting and Loading the Data Base ........ 19
RRFIS OPERATION AND MAINTENANCE ........ 20
    Data Base Size and Computer Hardware for the DBMS ........ 20
    GIS Data Base Size and Computer Hardware ........ 21
    Public Sector vs. Private Sector Software ........ 21
    Data Base Accessibility and Use ........ 22
    Software Support and Technical Assistance ........ 23

REFERENCES ........ 24
GLOSSARY ........ 26
APPENDIX - DATA COLLECTION FORMS ........ 29
    Exhibit 1. National Fisheries Survey Data Collection Form ........ 30
    Exhibit 2. BIA/Hoopa Valley Indian Reservation Data Collection Form ........ 40
    Exhibit 3. Tennessee RRFIS Application Data Collection Form ........ 50

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# INTRODUCTION

State and Federal environmental legislation coupled with increased demand for water resource development and recreation have rapidly escalated requirements for fisheries and aquatic habitat information. Basic techniques for solving resource problems require information, whether it be related to inventory, impact assessment and mitigation, resource management, or planning. In most cases, the amount of information and the need to repeatedly use data in a variety of complex scenarios mandates automation of the data via computer systems.

While an abundance of information is available on fish communities and aquatic habitat in the United States, the data vary in quality and coverage and have not been compiled or compared effectively. The reasons for this situation were addressed by Besadny (1979) and Hirsch et al. (1979):

1. Inventory methods vary from State to State.
2. No regional or National standard methods exist for data gathering, storing, and retrieval.
3. State and Federal agencies have different organizational structures and legislation for carrying out resource management programs.
4. Lack of adequate funding, differing agency needs, fluctuating population levels, and overlapping laws confound the problem.

The need for computer-assisted wildlife habitat management has been widely recognized by both State and Federal agencies (Besadny 1979; Hirsch et al. 1979; Mason et al. 1979). Not only can computers provide rapid access and analysis of raw data, but they also encourage clarity and consistency of information for use by a wider range of users. Resource managers have made decisions for decades without the use of computers; however, that is not to say these decisions were as comprehensive or as sound as they can be today. The challenge in designing computer systems today centers around methods to ensure that the data base contains high quality information necessary to do the job at hand and that managers are trained to easily and effectively use the system. A third characteristic of a successful data base is its compatibility with other natural resource data bases and its utility on a broad, regional or National level.

The Fish and Wildlife Service's Western Energy and Land Use Team (FWS/WELUT) is in the final stages of a project designed to address certain data needs of natural resource managers. The objective has been to develop an automated computer system that can: (1) help monitor the condition of fisheries and aquatic habitat regionally and Nationally; and (2) serve as a site-specific fishery management tool for State and Federal decisionmakers. The result is a combination of methodology and computer technology called the River Reach Fisheries Information System (RRFIS).

The RRFIS is a data organizing tool that uses standard U.S. Geological Survey (USGS)/Water Resources Council (WRC) hydrologic unit maps, the U.S. Environmental Protection Agency's (EPA) River Reach File (RRF) numbering system (Horn 1981), and existing natural resource information. The RRF was developed by the EPA to catalog all of the Nation's waters by assigning a unique alpha-numeric identifier to each stream segment or reach. The term reach refers to that portion of a stream or river that extends downstream from one confluence of a stream, river, or lake to the next confluence. Water bodies in the RRF were digitized from National Oceanic and Atmospheric Administration (NOAA) aeronautical charts, labeled, linked hydrologically, and then computerized. Each reach was identified by an 11-digit code, with the first eight digits representing the U.S. Geological Survey cataloging unit coding and the last three representing the unique river reach code. Within the basic structure of the RRFIS, a wide variety of data can be assembled in a hydrologic hierarchy, based on Nationally accepted unit codes and common reach numbers that cross reference to other existing natural resource data systems. The RRFIS provides interactive data base management and geographic information system (GIS) capabilities that can be customized to meet each user's special needs. A GIS is a software system that primarily deals with spatial or geographic data and is composed of three basic constituents: data entry; data analysis; and data output.

The purpose of this document is to provide users with a step-by-step guide to designing and implementing a RRFIS for their own resource needs. In addition, the concepts underlying this particular approach to managing fishery and aquatic resources are discussed and, thus, provide readers with a framework within which they can create more customized systems. User manuals for each of the computer technologies used in the RRFIS are already available (Imel and Reedy n.d.; Lee n.d.; Shumate et al. 1982). The reader is provided with a glossary for clarification of the terminology and acronyms frequently used in this report. An appendix is provided containing specific applications of the RRFIS mentioned in this report.

## DEVELOPMENT OF THE RRFIS

The RRFIS, at its completion, represents many years of interagency effort directed toward designing a computer-assisted information system that addresses both National and site-specific needs. It was modified, changed, and evaluated in concept even before it was applied to several pilot management areas. Figure 1 summarizes FWS/WELUT development activities on the RRFIS project from 1978 to the present. These activities grew out of early attempts by the U.S. Water Resources Council (1977) and the U.S. Fish and Wildlife Service (1978a-j and 1980a) to develop map-based fishery classification systems for National and individual State waters. Concurrently, the EPA was developing a stream numbering system for National water quality monitoring purposes.

Method Development 1978-1979

(1) Developed format and categories for National Fisheries Survey
(2) Tested method through peer and user review

National Fisheries Survey 1981-1982

(1) Developed content of data base
(2) Incorporated River Reach File numbers

BIA/Hoopa Valley Reservation 1981

(1) Integrated with RAM/GIS technology
(2) Developed site-specific capability
(3) Demonstrated map scale independence
(4) Applied to anadromous fish management

FWS Regional Application 1982-1984:

Applied methodologies and technology to Region 6 Upper Colorado River Basin

State Application 1982-1984:

Applied methodologies and technology to the State of Tennessee

1984-1985 Wrap-up Activities

(1) Continue pilot application of the FWS Sea Lamprey application
(2) Complete documentation of standard methodology and approach
(3) Conduct evaluation on completed applications
(4) Publish documentation and provide training
(5) Transfer software and technology to Tulalip Indian Tribe

Figure 1. River Reach Fisheries Information System research and development activities: 1978-1985.

In 1978, the FWS and EPA identified the need for a survey for use in evaluating the biological status of the Nation's waters, pursuant to EPA's responsibilities under Sections 101(a) and 104(a)(5) of the Clean Water Act, P.L. 95-217. The Survey would be based on existing information. In July 1978, the FWS/WELUT entered into a multiphased 5-year interagency agreement with EPA to design a methodology for assessing the "biological integrity of the Nation's waters." This required the development and evaluation of a biologically-based method that was Nationally consistent and technically sound. It was agreed that the FWS would assist EPA in developing a survey instrument (questionnaire) to be sent to State fish and game agencies Nationwide in order to assess the condition of the Nation's sport fish populations, as an indicator of the Nation's water quality. This action was determined to be the best practical way to aid EPA in water quality monitoring. The objectives of the survey were:

1. The production of statistically-based estimates of the ability of the Nation's water to support sport fish communities and species of special concern;
2. The development of a method to assess fish community conditions that was feasible to implement and practical to use;
3. The development of techniques that had Nationwide application;
4. The compilation of existing data (where possible); and
5. The development of a system that could be updated and revised on a regular basis.

An equal component of the agreement specified that EPA would provide funds to support the FWS development of a fishery management tool, which could benefit both FWS programs and State agencies. Financial resources were transferred to the FWS/WELUT over the course of 5 years to support work toward these goals.

To determine the scope of the initial activity and lay the groundwork for later efforts, an interagency planning meeting was convened in October, 1978, in Fort Collins, Colorado. Attendees at the meeting included representatives from the FWS, USGS, and EPA who were conducting biological monitoring or who would be potential users and/or suppliers of information for the RRFIS. Given the available time and resources, the interagency planning team concluded that the 1978 Stream Evaluation Maps for 10 western States (U.S. Fish and Wildlife Service 1978a-j) and the WRC's Streams of National Significance for Fish and Wildlife Map (U.S. Water Resources Council 1977) should be reviewed and analyzed to determine the status of fishery resources for 437 monitoring stations. Because these maps were compiled to meet different objectives, the interagency planning team suggested that the initial effort also assemble existing information on the status of fisheries and other aquatic life at each of these monitoring stations by surveying professionals in the field. Participants at the meeting also discussed the direction of future efforts to determine the status of fishery resources in the United States. An intermediate phase was recommended whereby information on the status of fisheries and other aquatic life for those stations with qualitative evaluations would be collected, evaluated, and ranked. In addition, the team discussed and proposed a number of factors to be contained in the descriptive summary of the RRFIS, such as species present and limiting factors affecting reach use potential.

A report was prepared (U.S. Fish and Wildlife Service 1980b) that provides a National overview of the type, quality, extent, and overlap of existing information on fisheries and aquatic habitat for a sample of reaches associated with 437 monitoring stations. The sample reaches were classified on the basis of the two sets of maps mentioned above. Although a substantial amount of fisheries-related information relevant to the sample reaches was found in State, Federal, and private repositories, the classification scheme used for the study resulted in an inordinate number of reaches being categorized as "unclassified fishery resources". This was a result of the fact that a large number of the reaches were not evaluated on either set of maps.

Existing and proposed methods for biological classification and monitoring were reviewed; all were determined to be inadequate for National application. Therefore, a standardized statement classifying the type and quality of fisheries in reaches was designed. Fisheries type was characterized by the species present, relative fish abundance, habitat categorization, and other parameters. Reproductive capacity, species diversity of the fishery, and degree of contamination reflect fishery quality. The system proposed was independently reviewed by prospective users in all State fish and wildlife agencies, State water quality agencies, EPA, and FWS regional offices and research and development facilities, as well as by academic experts. The reviewers' concerns were jointly considered in 1979 at an interagency workshop that critiqued an earlier version of the proposed system and solicited guidance on an approach (Olson et al. 1981). As a result of this input FWS and EPA jointly developed a questionnaire.

In 1980, a prototype survey tested the questionnaire in nine States. Also, all 50 States were contacted to determine the frequency with which States obtained fisheries survey information and the accessibility of that information by computer. Results indicated that most State agencies (70%) conducted stream fishery/habitat surveys only as needed; the type and complexity of information and methods of collection were highly variable, and fewer than 10 States had any computer facilities available for fisheries resource data storage and handling. The prototype survey also attempted to determine the availability of other types of biological data, e.g., data on macroinvertebrate and periphyton, possibly collected by State fish and wildlife agencies. The results of this prototype survey (Olson and Nystrom 1981) were used to modify the National Survey Questionnaire.

A National Fisheries Survey was conducted in 1981-1982 using a questionnaire modified by results from the prototype survey; results were published by Judy et al. (1984). This survey established the extent of fishery information available at the National level, which would then form the minimum data set of information for all further RRFIS applications. The RRF numbering system was incorporated as the sampling frame to ensure National consistency.

## APPLICATIONS OF THE RRFIS AS A MANAGEMENT TOOL: DEVELOPMENT AND TESTING

The FWS research objective was to develop and test the applicability of the RRFIS technology at National, regional, State, and site-specific levels. Testing was designed to evaluate the merits of the system and computer software to meet planning, inventory, and management information needs at different levels of resolution.

The Hoopa Valley Indian Reservation, in 1981, was the first pilot application to test the usefulness of the RRFIS as a management tool. This application was important for the following reasons:

1. The RRF numbering system was adapted to the existing FWS-developed software, FWS/MANAGE.

2. A site-specific data set was developed that included the minimum data set from the National survey.

3. Map scale independence was demonstrated (i.e., data could be assembled from streams occurring on both the 1:500,000 USGS/WRC hydrologic unit maps and the 1:24,000 USGS quad maps).

4. A map update procedure was developed to expand the RRF to other map scales (Ludwig and Solomon 1982).

5. The resulting RRFIS was incorporated into the U.S. Bureau of Indian Affairs' (BIA) Hoopa Forestry and Anadromous Fishery Management Plan and transferred to the BIA Sacramento Area Office; WELUT trained the BIA on the use of the RRFIS.

A pilot FWS application for Region 6 was initiated on the Upper Colorado River Basin 1982-84 to assist resource planners and fishery biologists. For this application, the concept of a directory was developed to help access other available State or regional data bases. In addition, a pilot application for the entire State of Tennessee was initiated for transfer to, and use by, the Tennessee Wildlife Resources Agency (TWRA) as part of their comprehensive fish and wildlife planning capability. Numerous requests were received from State and Federal agencies in Tennessee to implement the RRFIS for the TWRA, resulting in a steering committee meeting to determine the content of the data base. Funds for the project were solicited from participating agencies, and several cooperative agreements were drafted for future transfer of funds. This project was turned over to the TWRA in 1984 for implementation of the system. A pilot test of RRFIS is being conducted in 1985 in two river basins tributary to Lake Superior for the FWS Sea Lamprey Control Program. The technology has also been operationally installed and transferred to the Tulalip Indian Tribal Council fishery program in Washington.

## DESIGN AND CONCEPT OF RRFIS

Based on the development effort, several requirements were identified as necessary for implementation of the RRFIS concept. Each RRFIS application should entail:

1. The use of RRF numbers, including new numbers updated to correspond with USGS/WRC 1:500,000 scale hydrologic unit maps;

2. Digital data entry of numbered stream segments;

3. A minimum application area of one hydrologic cataloging unit (C.U.), which is the equivalent of a large watershed; each C.U. has a unique 8-digit number depicted on USGS/WRC hydrologic unit maps;

4. A minimum data set based on the National Fisheries Survey form (see Exhibit 1, Appendix), to which more detailed, customized data fields can be added; and

5. A data base management system for text, tabular, and geographic information.

These structural requirements allow effective data display and analyses particularly suited for aquatic resources. By incorporating these elements in the RRFIS, users are assured the following advantages: national standardized reference for streams using numbers representing an accepted hydrologic hierarchy; standard, minimum detail map base using the USGS/WRC 1:500,000 scale hydrologic maps; and efficient access to other data bases using accepted reach numbers. Also, the interactive data base management system is available and supported by the FWS (FWS/MANAGE). This system allows synthesis and analysis of data hydrologically (upstream and downstream) within watersheds. The geographic and spatial data analysis enables map production to visually display such items as areas of productivity, population characteristics, resource development conflicts, and point data, among others. The design of the interactive data retrieval encourages routine updates of data base information for improved quality in analysis and decisionmaking. A flexible data base design is easily customized for a specific purpose, while also containing a common set of data useful for regional or national planning. RRFIS focuses on available information used routinely in management decisions; this focus ensures minimum dollars spent to build and maintain a data base with maximum benefits in everyday use. Finally, training and technical assistance are available through FWS natural resource personnelfor a nominal fee; FWS software is available as public domain software (i.e., no lease or license is required) on a cost-recovery basis.

Among the strengths of the RRFIS are those commonly associated with most computerized natural resource data bases:

1. Enhances credibility in decisions, because information is backed with referenced hard data;

2. Allows speed and accuracy in retrieval and analysis of large amounts of data;

3. Provides information in an immediately usable format;

4. Facilitates access to best available information without comprehensive literature searches or field tests;

5. Necessitates clear identification of needs by users during the development stages of the data base;

6. Helps to identify geographic areas of importance, trouble spots, and data gaps;

7. Provides a format for new data collection; and

8. Is easy to use.

In general, a computerized data base is needed if large amounts of information, in complex relationships, must be reviewed on a frequent basis. The RRFIS approach is useful for fishery resource and habitat management, environmental impact analysis, planning (areawide/regional/National), facility siting, compliance monitoring, stream classification, aquatic inventory, and monitoring effectiveness of management practices and control technologies. The implementation of laws such as the Clean Water Act (Sections 208, 303, 402, and 404), Rivers and Harbors Act (Section 10), Endangered Species Act (Section 7), Federal Power Act, and Surface Mining Act might be facilitated through use of RRFIS.

An important distinction should be made between a data base and an information system. Two types of basic computerized data-retrieval systems exist: (1) a true data base that contains all of the raw data collected (e.g., numbers); this type of data base is most frequently used as a basis for statistical analyses, inventory, and historical trend analysis; and (2) an information system, which typically stores summarized or most current data, provides linkage to other computerized data bases or references, includes comments or data interpretations based on professional judgement, and focuses on management-related needs. For example, a simple data base may contain all empirical measurements of a particular parameter at a specific location over some time interval (e.g., lists of fish species collected annually at station X over the years). In effect, the data base serves as an automated log book or file cabinet. An information system attempts to summarize, interpret, and evaluate these data, focusing on a specific management issue; e.g., sport fishery value, quality of the stream segment, need for stocking, or habitat or water quality degradation affecting the fishery. The RRFIS, by its name, implies the latter concept. However, the RRFIS does allow raw data (usually summarized to save space and cost) to be incorporated where other data bases are not available. RRFIS applications, to date, have included raw data on parameters such as fish and invertebrate species population estimates. All of these applications refer to existing data bases for water quality information, such as STORET. Thus, other data bases do not have to be duplicated, because the RRFIS can be both a data base and an information system.

The key points to be considered when designing a RRFIS data base are: (1) management needs and budget; (2) need for textual, tabular, and geographic information and analysis; (3) level of detail required; (4) access to the textual/tabular data base, investment of funds to customize software, or the purchase of a lease for a private system; (5) areas/watersheds that should be included; (6) the system user and who will be responsible for system operation and maintenance, if not the FWS; (7) data base security needs; (8) controlling the size and number of data fields to ensure relevance to management or regulatory decisionmaking; and (9) the ultimate (long term) purpose, volume, longevity, and complexity of the data to be incorporated. These important considerations are discussed in the following chapters.

# IMPLEMENTATION OF THE RRFIS

Once a potential user identifies the need for an automated data base or information system, the first decision needed concerns how and where the system will receive funding for development and long term support and maintenance. This decision will guide subsequent steps toward implementation.

## STEERING COMMITTEE

For large management areas, it usually is advisable to consider forming a steering committee to guide the formation of the data base, as well as to encourage joint funding and support. In general, the agency legally responsible for the area of application (in most cases, a Federal or State agency) should take the lead responsibility for use and maintenance of the data base. The lead agency usually has or collects the bulk of the raw data and is the most frequent user of the information. Other agencies represented on the steering committee should, in exchange for use of the data base, contribute funds for its development and long term maintenance. Because they contribute financially, steering committee members may take an active role in deciding the structure and content of the data base. Due to the sizable, up front costs of data base development, the steering committee concept is desirable. The interagency committee approach has worked well in the Tennessee RRFIS application.

A similar committee also can be used when only one agency is involved. In this case, a committee formed of all of the potential users will help ensure a useful product. Intra-agency committees were used in the Hoopa Valley and the FWS Region 6 applications and in a new start for the FWS Sea Lamprey Program. A similar steering committee approach has been applied successfully in several FWS procedure State data bases (Porter et al. n.d.), where the following advantages to resource management were identified:

1. Reduces total costs to each organization needing fish and wildlife information;
2. Provides a coordinated, centralized data base that can be managed and updated;
3. Helps ensure consistency and quality control of data among users;
4. Provides a more complete synthesis of fish and wildlife information to manage the resource; and

5. Focuses diverse enforcement and management activities into a more biologically effective framework.

Steering committees should be formed by the lead agency; they are responsible for contacting the numerous potential contributors and users of the data base and for setting up the initial meeting. At this time, a brief cost/feasibility proposal should be developed in cooperation with WELUT Wetland Ecology Group staff or a private vendor. Initial proposals are always developed with the understanding that the cost estimates are preliminary. A number of assumptions must be clarified before an accurate cost/time estimate can be made.

One disadvantage of the multiagency steering committee approach is the potential increase in size and complexity of the data base as each agency requests that its special interests and data needs be incorporated. Increases in size and complexity translate directly into increased costs for data collection, entry, and storage and computer utilization. Increasing the size and complexity of each data record and the overall data base also limits flexibility in selecting computer software and hardware.

Similarly, there may be a tendency to include all data ever collected, whether or not these data will ever be used or are relevant to management or regulatory decisionmaking. The desire to put "everything you ever wanted to know" in a single data base greatly increases the development, operation, and maintenance costs, accompanied with little increase in user efficiency or effectiveness.

An example of the preceding possibility occurred during the development of the Tennessee Aquatic Data Base System. Several steering committee members desired a data set for benthic invertebrates that would incorporate all species in the State. The justification for inclusion of these data was that the reclamation bond release for many surface coal mines was conditioned on the reestablishment of certain benthic invertebrate families. The number of invertebrate species native to Tennessee was massive, while the number of taxonomic families of invertebrates was small. Furthermore, very few of the requesting agency's field personnel were able to taxonomically identify benthic invertebrates below the family level. Consequently, implementing a data set containing all or even common invertebrate species would have increased the size and cost of the data base by several orders of magnitude, and the information would have been superfluous for the regulatory decisionmaker.

## CHOOSING THE COMPUTER ENVIRONMENT

The next important step in implementation is a commitment to the software, to be used for the data base management system (DBMS), and hardware (computer). This decision affects several key components and costs of data base development: (1) the costs for maintenance and operation; (2) method of access; (3) DBMS software support and enhancements; and (4) user training. The importance of deciding early which DBMS and hardware system to use cannot be overemphasized. Without the commitment of resources up front in the planning process, inefficient use of valuable personnel and dollars are likely.

The research, development, and all applications of the textual/tabular portion of the RRFIS were accomplished using the FWS-developed software program FWS/MANAGE, which is a general purpose DBMS. All applications of the RRFIS were accomplished on Control Data Corporation (CDC) CYBER mainframe computers at the NOAA computer facility in Boulder, Colorado. The CDC version of FWS/MANAGE is fully documented and is supported and maintained by the FWS (WELUT). Because of its size (over 65,000 lines of code) FWS/MANAGE operates only on a mainframe computer. An enhanced version of FWS/MANAGE has been developed commercially for use in the 32-bit, minicomputer environment. Two earlier versions of FWS/MANAGE were developed for IBM and Univac mainframes, but are not currently supported by the FWS. Although the RRFIS concept should be compatible and transferable to other public and commercial sector DBMS/GIS software (and associated hardware), this document is limited to the FWS's actual experience with the mainframe CDC version of FWS/MANAGE.

FWS/MANAGE has several attributes that make it particularly useful for RRFIS data base management. An analysis of available public sector DBMS's suitable for hydrologic data analyses was conducted by EPA and the FWS (Tobin and Mehta 1981). FWS/MANAGE was selected for its statistical and interactive capabilities, in particular the ability to retrieve data in a hierarchical manner. Water quality analysis, as well as inventory and classification of fish and wildlife habitat, requires that pertinent data be associated with the appropriate river reach and be retrievable in hydrologic order. EPA's RRF provides a mechanism for associating data with specific map-based geographic and hydrologic locations (reaches). However, the RRF is an organizing tool, not a data base management system. Therefore, the RRF numbering system was adapted to FWS/MANAGE DBMS software, resulting in the RRFIS. The RRFIS provides the capability to analyze, store, and retrieve data hydrologically by stream segment (a type of hierarchical retrieval). The ability to organize, retrieve, and analyze data hydrologically, as well as to perform sophisticated data manipulations interactively, are essential requirements of a RRFIS DBMS. Additional advantages of the FWS-supported computer environment are outlined in Data Base Operation and Maintenance. If another DBMS is selected, additional costs must be anticipated for software leasing and, possibly, for enhancements necessary to meet RRFIS operating specifications.

# BUILDING THE RRFIS

Actual construction of a RRFIS data base can take two or more years. Although the steps outlined in this chapter are presented in a logical sequence, some activities can proceed concurrently, while others can be deleted or modified, depending on the particular application.

Scoping costs are presented with each step; these costs are actual labor costs and do not include FWS/WELUT overhead rates. With the exception of costs related to project management by FWS staff, all costs are associated with contractor support for computer services. For this reason, cost estimates must be adjusted yearly to reflect changes in contractor rates. The contractor costs cited represent negotiated preferred client rates for on-site Federal support contracts and may not be representative of costs to non-Federal support entities. Appropriate FWS/WELUT computer services are under contract agreements with private sector firms; this arrangement is responsive and cost-effective for routine applications. However, FWS/WELUT staff (Technical Support Services Section) are experienced in computer operations and maintain close technical direction over contract personnel, most of whom work on-site at WELUT. The WELUT Project Officer responsible for RRFIS applications provides technical advice, biological design, and scoping, and acts as the interface between the user agency and the computer staff, including contract management and consultation. A range of costs are presented, from least to most expensive, based on WELUT experience over the last 4 years.

## STEP 1: STRUCTURE AND FUNCTION

Developing the scope, content, and structure of the data base is probably the most critical component in the system. Simply put, this entails deciding what information must be contained in the data base to meet user needs. Some tradeoffs generally are necessary to accommodate available funds and maximum data retrieval efficiency. The size (number of records, number of fields in each record, line length of fields, and accessibility of each field) of the data base primarily determines the costs associated with data entry (Step 6) and storage. Incorporating references to other data bases in order to maximize the use of existing information is recommended wherever possible (the information system approach). In some cases, the user may anticipate data collection in a new area and can reserve fields for this. However, large numbers of blank (no data) fields raise the costs of data storage, while providing little or no immediate benefit. Although fields can be added later, costs can be significant.

The best way to begin designing the data base structure is to ask users to identify the types of data currently used to make decisions (or solve operational problems). No single information system can be designed to cost-effectively answer all conceivable questions. Trade offs exist between the level of detail incorporated and the cost of information development and maintenance. The design goal should be to tailor the data base to incorporate elements that are considered critical to the management or decision-making objectives of the system. Superfluous or seldom used information should not be included.

Two examples of RRFIS data collection forms (collection forms dictate the final data base structure and content) are presented in the Appendix (see Exhibits 2 and 3). Note that each form contains elements of the minimum data set represented by the National Fisheries Survey questionnaire (see Exhibit 1, Appendix).

During the design phase, the acceptable sources of data and who will collect the data from these various sources should be determined. RRFIS applications have used both in-house staff and contract personnel to collect data. Regardless of who collects the data, a front-end quality control policy helps ensure that high quality data are used for addressing an agency's resource management problems. A data base cannot improve the quality of data it contains; establishing stringent guidelines for data sources and collection methods pays off in the long run. Also, consultation with data entry technicians during this step can minimize problems and costs encountered during computer data entry (step 6) by ensuring that the data collection form is designed to facilitate data entry programming and data entry.

| | | | |
|---|---|---|---|
| Step 1: Responsibilities: | Lead agency, with assistance from the FWS | Costs: | Staff time and production of data forms |

STEP 2: GEOGRAPHIC COVERAGE AND MAP SCALE

All RRFIS applications are conducted at a minimum map scale resolution of 1:500,000, based on the USGS/WRC hydrologic unit maps. Initial costs usually are developed for this scale on a C.U. basis. If a greater resolution is desired at a scale of 1:64,000 (15 minute quad maps) or 1:24,000 (7.5 minute quad maps) for example, final cost estimates are generated on a map by map basis because of the high variance in the number of reaches depicted.

As with most design considerations, tradeoffs exist between cost and level of detail. The use of a large map scale can omit small perennial streams that may contain aquatic life. Keup (in prep.) compared the results of using 1:62,500 scale and 1:500,000 scale maps to estimate National total stream lengths and volumes. He estimated that the 1:500,000 scale maps include between 65% and 75% of the Nation's river surface area and between 96% and 98% of the total river volume. Because volume is closely associated with available fish habitat, potential omissions of important streams from 1:500,000 scale maps are expected to be minimal.

The selection of the map scale is very important in determining the ultimate size of the data base because a separate record is created for each individual reach or stream segment. A RRFIS developed at a 1:500,000 scale may have 100 individual reaches per C.U., whereas a data base for the same C.U. at a 1:24,000 scale may have 1,000 reaches. Map scale selection should be governed by the intended uses and objectives of the data base. If the data base is intended as a general fishery inventory and monitoring tool for an entire State or region, a 1:500,000 scale should provide adequate resolution for most management, planning, or regulatory activities affecting aquatic resources. If, however, the objective of the data base is to provide detailed information for intensive multiple resource management on a small area, such as a refuge, park, or Indian reservation where extensive field data are collected, a 1:24,000 scale may be justified. The ability to correlate RRFIS data with other available spatial data (e.g., National Wetland Inventory maps, public land surveys, vegetation maps, and timber cuts) is another consideration when selecting map scale. The availability or existence of data for each reach at the selected map scale also needs to be considered. Reach records should not be created for 1:24,000 scale streams when data are available only for 1:500,000 streams.

After considering the costs and benefits of selecting quad map (1:24,000) vs. 1:500,000 scale map detail, the 1:500,000 scale may be recommended for the entire data base area, with quad map detail used in smaller areas of intensive management. This approach has been successfully applied in previous RRFIS applications.

Step 2: Responsibility: Lead Agency        Approximate Costs: Staff time

## STEP 3: UPDATING AND NUMBERING REACHES

Before data collection begins, each river reach (and corresponding data form) must be assigned an existing RRF number or given a new updated number. The three digit reach number modifies the eight digit USGS/WRC hydrologic code and serves to uniquely identify each stream segment or reach. Updates are necessary when RRF numbers have not been assigned for a given reach segment. Because RRF is based on aeronautic maps, it is not complete for all streams depicted on 1:500,000 USGS hydrologic unit maps and USGS quad maps. RRFIS applications require resolution to at least the hydrologic unit map scale and often to finer detail (see Step 2). The FWS has coordinated with the RRF data base administrator to produce an acceptable update procedure (see Ludwig and Solomon 1982, copies can be obtained from WELUT). Once EPA distributes written instructions for accepting updates, new reach numbers will be formally added to the RRF. Two reasons for maintaining compatibility with the RRF numbering system are: (1) EPA has developed reach numbers for all of the lower 48 United States at a 1:500,000 scale; and (2) EPA has added reach numbers as a searchable field in STORET, which allows the user to retrieve water quality data using the reach number.

During updates, FWS reach listings are produced that correspond to the RRF directories. The reach listing is a tabular representation of all reaches within a given C.U. (Table 1). Reaches are listed either alphabetically by river/stream name or numerically by reach number. The reach listing provides a hard copy index to the RRF plot maps. Plot maps display reaches with associated reach numbers.

From these listings, reaches can be identified and forms labeled prior to data collection. Each form will have a unique number, corresponding to its particular reach segment. If the user does not wish to create digital reach file plot maps (step 4), the updated reach number can be manually added to the base maps for field use. With the reach listing and the updated hard copy map, the user is able to relate the RRFIS data base to geographic areas of interest. All FWS applications to date have utilized digitized maps (see step 4), rather than developing manual hard copy map products.

Step 3: Responsibility: FWS/WELUT or Lead Agency    Approximate FWS Cost: $100/C.U.

## STEP 4: MAP DIGITIZING AND PLOT PRODUCTION

During the update procedure, reach numbers are placed on hard-copy hydrologic and/or quad maps. These maps are used by the FWS/WELUT cartographers and digitizers to enter stream traces and associated reach numbers into a computer, using the Wetland Analytical Mapping System (WAMS) software program. Three major advantages are gained by entering this type of geographic map data:

1. Each reach is assigned latitude and longitude coordinates that uniquely identify its location from a cartographic perspective. Analysis can be conducted on spatial or line data (e.g., how many kilometers of stream are in a watershed or how many streams have spawning gravels). The FWS Map Overlay and Statistical System (MOSS) software generates this type of geographic analysis. Spatial analysis can merge aquatic data with terrestrial spatial data and depict dams, barriers, point sources, stream values, and similar information.

2. Maps can be produced on remote graphic terminals for more precise, interactive geographic analyses. Also, a range of questions can be examined in a relatively short time period. Areas of concern can be analyzed and evaluated to determine resource conflicts and compatibility.

## Table 1. FWS Reach Listing for Hoopa Square Catalog Unit 18010211, 1:24,000 Scale

**Number of reaches in this list = 214**

**List of reaches in NUMERIC ORDER, by reach number and daughter reach qualifier. Basic information is the reach number, two (or one) up-reaches (by their numbers), one down reach, the river name, and a description to help locate the reach. There will be a second line for any reach with two down reaches, or if either up-reach is in a different catalog unit.**

**Date: 10-DEC-82 Time: 12:16:10**

| Reach no. | Up reach 1 | Up reach 2 | Down reach(s) | River name | Reach "description" |
|---|---|---|---|---|---|
| 001, 0.000 | 001, 1.000 | 500, 0.000 | 007, 0.400,18010209 | TRINITY RIVER | HOOPA STRIP & SQUARE |
| 001, 0.000 | 001, 2.000 | 501, 0.000 | 001, 0.000 | TRINITY RIVER | (NONE) |
| 001, 2.000 | 001, 3.000 | 604, 0.000 | 001, 1.000 | TRINITY RIVER | [UNKNOWN] TO BULL CREEK |
| 001, 3.000 | 001, 4.000 | 603, 0.000 | 001, 2.000 | TRINITY RIVER | MONKEY GL TO BULL CR |
| 001, 4.000 | 001, 5.000 | 602, 0.000 | 001, 3.000 | TRINITY RIVER | BIGTREE GL TO MONKEY GL |
| 001, 5.000 | 001, 6.000 | 601, 0.000 | 001, 4.000 | TRINITY RIVER | SKUNK CR TO BIGTREE GL |
| 001, 6.000 | 001, 7.000 | 600, 0.000 | 001, 5.000 | TRINITY RIVER | COYOTE CR TO SKUNK CR |
| 001, 7.000 | 001, 8.000 | 599, 0.000 | 001, 6.000 | TRINITY RIVER | NORTON CR TO COYOTE CR |
| 001, 8.000 | 001, 9.000 | 502, 0.000 | 001, 7.000 | TRINITY RIVER | LIMB CAMP CR TO NORTON CR |
| 001, 9.000 | 001,10.000 | 503, 0.000 | 001, 8.000 | TRINITY RIVER | BIG CR TO LIMB CAMP CR |
| 001,10.000 | 001,11.000 | 598, 0.000 | 001, 9.000 | TRINITY RIVER | [UNKNOWN] TO BIG CR |
| 001,11.000 | 001,12.000 | 506, 0.000 | 001,10.000 | TRINITY RIVER | (NONE) |
| 001,12.000 | 001,13.000 | 507, 0.000 | 001,11.000 | TRINITY RIVER | BEAVER CR TO [UNKNOWN] |
| 001,13.000 | 001,14.000 | 509, 0.000 | 001,12.000 | TRINITY RIVER | SOCTISH CR TO BEAVER CR |
| 001,14.000 | 002, 0.000 | 072, 0.000 | 001,13.000 | TRINITY RIVER | MILL CR TO SOCTISH CR |
| 002, 0.000 | 003, 0.000 | 071, 0.000 | 001,14.000 | TRINITY RIVER | HOSTLER CR TO MILL CR |
| 003, 0.000 | 003, 1.000 | 520, 0.000 | 002, 0.000 | TRINITY RIVER | SPRING CR TO HOSTLER CR |
| 003, 1.000 | 003, 2.000 | 521, 0.000 | 003, 0.000 | TRINITY RIVER | BROWN CR TO SPRING CR |
| 003, 2.000 | 003, 3.000 | 565, 0.000 | 003, 1.000 | TRINITY RIVER | FERRY GL TO BROWN CR |
| 003, 3.000 | 005, 0.000 | 004, 0.000 | 003, 2.000 | TRINITY RIVER | SUPPLY CR TO FERRY GL |
| 004, 0.000 | 004, 1.000 | 522, 0.000 | 003, 3.000 | SUPPLY CREEK | (NONE) |
| 004, 1.000 | 004, 2.000 | 527, 0.000 | 004, 0.000 | SUPPLY CREEK | (NONE) |
| 004, 2.000 | 004, 3.000 | 540, 0.000 | 004, 1.000 | SUPPLY CREEK | (NONE) |
| 004, 3.000 | 004, 4.000 | 539, 0.000 | 004, 2.000 | SUPPLY CREEK | (NONE) |
| 004, 4.000 | 004, 5.000 | 538, 0.000 | 004, 3.000 | SUPPLY CREEK | (NONE) |
| 004, 5.000 | 004, 6.000 | 528, 0.000 | 004, 4.000 | SUPPLY CREEK | (NONE) |
| 004, 6.000 | 004, 7.000 | 537, 0.000 | 004, 5.000 | SUPPLY CREEK | (NONE) |
| 004, 7.000 | 004, 8.000 | 530, 0.000 | 004, 6.000 | SUPPLY CREEK | (NONE) |
| 004, 8.000 | 004, 9.000 | 531, 0.000 | 004, 7.000 | SUPPLY CREEK | (NONE) |
| 004, 9.000 | 004,10.000 | 536, 0.000 | 004, 8.000 | SUPPLY CREEK | (NONE) |
| 004,10.000 | 004,11.000 | 535, 0.000 | 004, 9.000 | SUPPLY CREEK | (NONE) |
| 004,11.000 | 004,12.000 | 532, 0.000 | 004,10.000 | SUPPLY CREEK | (NONE) |
| 004,12.000 | 004,13.000 | 534, 0.000 | 004,11.000 | SUPPLY CREEK | (NONE) |
| 004,13.000 | 004,14.000 | 533, 0.000 | 004,12.000 | SUPPLY CREEK | (NONE) |
| 004,14.000 | 999, 0.000 | 999, 0.000 | 004,13.000 | SUPPLY CREEK | PARTLY WITHIN HOOPA SQUARE |
| 005, 0.000 | 005, 0.100 | 541, 0.000 | 003, 3.000 | TRINITY RIVER | HOSPITAL CR TO SUPPLY CR |
| 005, 0.100 | 005, 0.200 | 543, 0.000 | 005, 0.000 | TRINITY RIVER | [UNKNOWN] TO HOSPITAL CR |
| 005, 0.200 | 005, 0.300 | 562, 0.000 | 005, 0.100 | TRINITY RIVER | CAPT. JOHN GL TO [UNKNOWN] |
| 005, 0.300 | 005, 0.400 | 561, 0.000 | 005, 0.200 | TRINITY RIVER | [UNKNOWN] TO CAPT. JOHN GL |

3. As part of this step, hard copy, black and white maps are produced for each C.U. Hard copy color maps also can be produced and are useful for field and planning needs. For example, these maps can be used for project planning, discussion of projects with other agencies, and public presentations of projects.

Step 4: Responsibility: FWS/WELUT or private vendor Approximate FWS Costs: $100-200/C.U.

STEP 5: TEXTUAL/TABULAR DATA COLLECTION AND EDITING

Source(s) for data and personnel for data collection are identified prior to Step 3 (Updating and Numbering Reaches). In some cases, the data source(s) may be established files or may include literature references. Once Step 3 is complete, data collection can begin. One form (designed during Step 1: Structure and Function) for each river reach must be filled out and checked for accuracy by the lead agency. The forms must be legible and tied to a specific reach. In many cases, data are available only for an entire river, in which case there will be forms with identical information for each of the reach segments comprising that river. In some cases, one reach may have many sample points that must be kept separate. In this case, the reach is further subdivided, but retains its original reach number as part of the subdivision.

It is advisable for the principal investigator to develop an editorial protocol or checklist if more than one person will be involved in editing the raw data forms. This protocol should provide a consistent mechanism for correcting errors or omissions on the raw data forms prior to data entry. Once data are collected and checked for accuracy and clarity, the forms are ready for entry into a computer.

Step 5: Responsibility: Lead Agency Approximate FWS Costs: $500-1,000/C.U.

STEP 6: COMPUTER DATA ENTRY

The conversion of the hard copy information on the forms to an electronic- or computer-readable form requires data entry, which can be accomplished by card punching or through keyboard entry into a micro- or minicomputer. When developing an initial RRFIS data base where large volumes of data are entered in a production mode, it is desirable to develop an interactive data entry program that reflects the design and format of the raw data form. The data base design requirements for each RRFIS application are tailored to the needs of the user. Therefore, no universal data entry program has been developed by the FWS. If the user has a staff computer programmer and computer equipment, they usually can design their own simple data entry program, utilizing text/editor utility software. Most micro-, mini-, and mainframe computer manufacturers provide text/editor software specific to their machines.

The two costs involved in this step are for: (1) writing the data entry program; and (2) entering the data from the forms into the computer. The data entry program ensures that data is automatically checked and edited for accuracy when entered. If the user does not have computer personnel and facilities, both steps can be performed on-site at FWS/WELUT. If FWS/MANAGE is used as the DBMS, a tape of the raw data is retained for formatting in Step 7. Should another DBMS be chosen, a tape of the raw data is sent to the lead agency. The data on this tape is in readable form (flat file) to allow formatting into the selected DBMS. The size of each record (i.e., data collection form) determines the actual costs for data entry; the costs for developing a data entry program are less variable.

Step 6: Responsibility: FWS/WELUT or Lead Agency

Costs: $2,500 for the data entry program
$200-300/C.U. for data entry

STEP 7: FORMATTING AND LOADING THE DATABASE

Once the data is entered and checked for accuracy, it is formatted into a functioning data base. Build forms are used to group separate data fields into units, or data sets, allowing logical manipulation and retrieval of data. The build forms and formatting steps are specific to the selected DBMS. The MANAGE data base formatter will consult with the lead agency to determine which fields should be searchable vs. nonsearchable and which will be key fields.

A tape of formatted MANAGE data is produced for loading onto a Cyber computer. Once the data base is loaded and the appropriate accounts established, it is ready for use. Average costs for operation and maintenance are included in the chapter on Data Base Operation and Maintenance.

Step 7: Responsibility: FWS/WELUT (or Lead Agency if another DBMS is selected)

Costs: $1,600 for formatting data
$800 for loading data

## RRFIS OPERATION AND MAINTENANCE

The operation and maintenance costs of a RRFIS are dependent on a number of variables, including: (1) the amount of magnetic disk required for storage of the data base [in Physical Resource Units (PRU's)]; (2) whether the data base is in-house (agency-owned computer) or at a leased computer facility; (3) whether public sector or licensed private sector software is utilized for the DBMS and GIS; (4) how often the data base is on line and, thus, accessible; (5) how often the data base is accessed [in Computer Processing Units (CPU) seconds]; (6) phone line and connect time charges (for remote access); and (7) software support and technical assistance costs.

The preceding discussion was based largely on FWS experience during the development of the Hoopa River Reach Data Base and reflects costs associated with leased computer space on the NOAA CYBER computer. These estimates may not reflect current costs at CYBER computer facilities at other Federal, State, or private locations.

### DATA BASE SIZE AND COMPUTER HARDWARE FOR THE DBMS

The size of the data base is determined by the number of PRU's or disk blocks occupied by the data base on a computer disk. One PRU is equivalent to 640 bytes of information. In terms of a RRFIS data base, total size is determined by the number of individual reach records and size (number of characters in each field and number of fields in each record) and configuration (number of duplicate fields in each record) of the data base. Both of these factors are affected by the design and complexity of the raw data forms and the map scale selected for the data base (see steps 1 and 2). The DBMS software (executable code) also uses disk space and must be included in the disk storage cost.

The major cost determinant for data base and DBMS software storage costs is whether the lead agency owns the computer or must lease disk space on some other computer. If the lead agency or user owns the computer, disk storage costs may be minimal. More typically, the lead agency or user must lease space on a university or other agency computer. Depending on the data base size and frequency of access, it often is more economical for the user to lease an entire dedicated disk than to lease space on the computer facility's disk. Some computer facilities limit the size of a data base they will support on a nondedicated disk. Disk storage costs usually are calculated in cost/thousand (k) PRU's/day. The current cost on the FWS-leased disk at the NOAA computer facility is \$.30/K PRU's/day. The FWS/MANAGE executable software occupies 11,430 PRU's of disk space ($3.43 per day) if stored on-line at NOAA on the FWS disk. This converts to an annual disk storage cost of $7,134 for on-line access 5 days/week (2,080 working hours/year). The Hoopa RRFIS data base occupies 14,720 PRU's of disk space or $9,194/year if it is on-line accessible 5 days a week. This represents a total annual cost of $16,328 for full time access on the NOAA FWS-leased disk. Any files that are created from the data base and stored on the disk also are subject to PRU storage charges. These costs are presented solely to illustrate the level of resources needed to store the data base on leased disk space, and that disk storage is a major cost of maintaining a RRFIS data base. These costs vary greatly among different computer facilities, so obtaining several cost estimates may be advantageous. Other mainframe and minicomputer DBMS software available in the public and private sector could be adapted to the RRFIS concept. The FWS has utilized one such private sector DBMS (minicomputer) software experimentally for the Tennessee Aquatic Data Base, with good results.

## GIS DATA BASE SIZE AND COMPUTER HARDWARE

The GIS software (WAMS, MOSS, and COS) utilized in the RRFIS was developed to operate in a Data General Corporation minicomputer environment. The MOSS software recently has been converted to operate in a Digital Equipment Corporation VAX minicomputer environment and on the Data General desk top microcomputer series Models 10/SP, 20, and 30. The data entry and map output software (AMS and COS) currently operate in the Data General minicomputer environment. Production data entry, data base construction, and map output are available through Federal agencies and private contractors. WELUT can be contacted for detailed information on MOSS/GIS capabilities. The RRFIS concept should be adaptable to other GIS software and hardware available in the private sector, although the FWS has had no direct experience in doing so.

## PUBLIC SECTOR VS. PRIVATE SECTOR SOFTWARE

The RRFIS was developed utilizing public sector software (FWS/MANAGE, AMS, MOSS, and COS) developed by the FWS/WELUT. Public sector software includes software that is produced by or at government expense and is, therefore, available to the public at minimal cost (usually cost-recovery for duplication). Private sector software includes software developed using private capital that is protected under Federal and State law as the proprietary property of the developer. Such software usually is sold to users under license agreement.

From the RRFIS perspective, the decision to acquire public or private sector software has a major impact on operation and maintenance costs because public sector software does not require payment of a license fee. Software enhancement and documentation usually are made available at cost to users as they are developed. Enhancements in public sector software usually are dictated by the developing agency and are subject to the uncertainties of the governmental budget process.

Private sector software, both DBMS and GIS, are available to users to implement a RRFIS. Private sector software is acquired through a multiyear license agreement with the owner (private firm) with costs from $20,000 to $80,000 per computer installation. The license fee usually covers training, documentation, and software enhancements. The vendor may or may not include technical support for software users in the license agreement. In general, the individual licensee may not substantively modify the software. Any software enhancements needed by a specific user must be accomplished through the vendor for an additional fee. License fees, duration of the license, and services provided vary widely between vendors.

## RRFIS ACCESSIBILITY AND USE

Use of the computer to access and manipulate a RRFIS is measured in System Resource Units (SRU). A number of other items are added to the SRU charge at the NOAA facility, including computer connect time, data printing, tape mounting, and tape storage. Analogous cost items exist at all computer facilities. Example costs at the NOAA facilities are connection time charges of $2.25/hour and useage charges of $0.08/SRU. The cost of computer processing time varies between facilities, and depending on whether the computer is owned by the user agency or leased on a time-share basis. Most computer facilities have accounting facilities and algorithms to trace each authorized user's account and bill users directly for operational costs. If the RRFIS data base is intended for multiple agency access on a time-shared basis, the lead agency (data base owner) usually can elect to either pay all processing and data storage costs and bill the user agencies or have the computer facility bill users directly. Each user generally must pay for his or her own telephone connect time for remote access to the data base.

Accessibility refers to how often the data base is available to the user. The cost figures provided earlier for computer storage at NOAA were based on full time, on-line access 24 hours/day, the most expensive option. A number of other options are available to the data base owner that substantially reduce these costs.

One of the first things that the lead agency or data base owner must determine is how often and during what time of the day the data base can be accessed. Time-shared and in-house computers have a prime time for use (typically 8:00 a.m. to 5:00 p.m., Monday through Friday). Most computer facilities charge a premium rate for prime time access. Weekend and evening access generally is billed at a lower rate. If the user needs to access the data base less than daily, e.g., once a week or once a month, it may be desirable and cost effective to copy the data base from the computer disk onto tape and archive the tape. This can save substantial disk storage costs. Large printing jobs or major updates to the data in the data base can be done during off-peak hours at lower rates at most facilities. The cost effectiveness of many of these options are dependent on the size and structure of the data base and the operating policy of the computer facility.

## SOFTWARE SUPPORT AND TECHNICAL ASSISTANCE

Software support and technical user assistance for RRFIS data bases developed by the FWS during the research and development phase was provided through a combination of Federal staff and support service contract personnel. Training courses in MANAGE and GIS software are available through Colorado State University, Office of Conferences and Institutes, and the FWS on a cost-reimbursable basis. User agencies interested in acquiring FWS/MANAGE or GIS software, designing and building RRFIS data bases, routine technical assistance, software enhancements, or similar items, can obtain these services on a cost-reimbursable basis through the FWS/WELUT or support contractors. Interested parties should contact the Manager, Technical Support Services Section, WELUT.

Private sector software support and technical assistance is available from the various vendors either as part of their license fee or as a separate service support contract. Costs for the latter arrangement generally range from $2,500-$15,000/year, depending on the needs of the client and the vendor selected. Depending on the extent and nature of the software and technical assistance needed, similar costs can be anticipated for support through the FWS.

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______________________. 1978c. Stream Evaluation Map, State of Nebraska. U.S. Fish Wildl. Serv. (map 1:250,000)

______________________. 1978d. Stream Evaluation Map, State of Nevada. U.S. Fish Wildl. Serv. (map 1:250,000)

______________________. 1978e. Stream Evaluation Map, State of North Dakota. U.S. Fish Wildl. Serv. (map 1:250,000)

______________________. 1978f. Stream Evaluation Map, State of Oklahoma. U.S. Fish Wildl. Serv. (map 1:250,000)

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______________________. 1978h. Stream Evaluation Map, State of Texas. U.S. Fish Wildl. Serv. (map 1:250,000)

______________________. 1978i. Stream Evaluation Map, State of Utah. U.S. Fish Wildl. Serv. (map 1:250,000)

______________________. 1978j. Stream Evaluation Map, State of Wyoming. U.S. Fish Wildl. Serv. (map 1:250,000)

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# GLOSSARY

alpha-numeric - Any character, including numbers, letters, and special symbols.

character - A value produced by a single keystroke on a computer terminal.

COS - The Cartographic Output System is a component of the geographic information system for enhanced cartographic plotting.

CPU - Central Processing Unit is the part of a computer that includes the circuits controlling the interpretation and execution of instructions. The number of CPU's used by a data base is a reflection of the time spent accessing the computer, which is a product of the number of questions asked, their complexity, and the time the software takes to answer the questions. For example, more CPU's are used to retrieve complex data from a large data base than simple data from a small data base. Also see hardware.

CU - A cataloging unit is the smallest unit on hydrologic unit maps, usually a single subdrainage basin.

data set - A named collection of physically similar records.

DBA - Data base administrator is the person charged with the responsibility for the integrity and security of a data base.

DBMS - Data base management system is a collection of computer programs that facilitates the integration of related data to a community of users who access the data in a variety of ways.

directory - The descriptive list of data sets within a data base.

disk - A computer storage device where data can be stored or retrieved rapidly.

field - One segment of information; in a manual system, a named blank space on a form is a field.

FISH KILL file - A computerized data base on fish kills developed and maintained by the U.S. Environmental Protection Agency in cooperation with the States.

GIS - A Geographic Information System is a software system which primarily deals with spatial or geographic data and is composed of three basic constituents: data entry; data analysis; and data output.

hardware - The physical components of a computer, for example, mechanical, magnetic, electrical, or electronic devices.

interactive - A system of computing that immediately returns software responses to the user at the user's terminal.

lead agency - The agency responsible for establishing the need for and overall design, use, and maintenance of a data base. Usually a person from the lead agency serves as DBA and is responsible for organizing the steering committee, ensuring quality control procedures, and controlling access to the data base.

mainframe - Generally, the central computer hardware (as opposed to remote terminals); the term also is used to distinguish between large computers and mini- or micro-computers.

FWS/MANAGE - Interactive software for storing, retrieving, and manipulating data in a data base developed by the U.S. Fish and Wildlife Service. One example of a data base management system.

MOSS - The Map Overlay and Statistical System is an analysis and display system for map and other information. It is designed to allow users to retrieve, analyze, and display maps and spatial data stored in the system.

program - A set of instructions (written in a computer language like FORTRAN, COBOL, or BASIC) that directs the computer to perform various functions.

public domain software - Software developed by the Government whose use does not require a lease or license.

PRU - A Physical Resource Unit. It is the amount of space used on a disk. One PRU contains 640 bytes of information.

records - An aggregate of data fields. In RRFIS applications, one data collection form corresponding to one river reach constitutes a record.

RRF - The River Reach File is a data base developed by the U.S. Environmental Protection Agency which identifies and catalogs, by computer, all the hydrologic features of the United States, resulting in a digital data base of streams and lakes. It provides a framework for simulated routing of streamflow and pollutants through the Nation's river systems.

RRFIS - The River Reach File Information System is a data organizing tool that uses standard U.S. Geological Survey/Water Resources Council hydrologic unit maps, the U.S. Environmental Protection Agency's RRF numbering system, and existing natural resources information.

searchable fields - These are fields in the data base that the user wants to summarize or analyze across all records (reaches). Examples of searchable fields are fish species, habitat values, water quality values, cataloging unit numbers, management type, and migration blockages. Typically, variable-length fields, such as comment sections, are not searchable. Searchable fields can be selected easily by conceptualizing the kinds of questions that will be asked of the data base and the fields of information necessary to answer the questions.

software - A set of programs, procedures, and associated documentation concerned with the operation of a data processing system. The written programs that are used as computer instructions.

STORET - A computerized data base containing raw data on water quality data from stream and lake gages, STORET was developed and is maintained by the U.S. Environmental Protection Agency in cooperation with State and local governments, as well as industry.

user - Any person involved in data storage or retrieval.

value - Information contained in a single field within a record.

variable length - Fields whose field values may vary from 0 (no field value) to 200 characters.

WAMS - The Wetland Analytical Mapping System is the data entry subsystem of the Geographic Information System. WAMS reformats Analytical Mapping System data to Mapping Overlay Statistical System. WAMS used to be known as the Analytical Mapping System.

WATSTORE - A computerized data base on water quality and quantity for surface and groundwater gaging stations for the United States. This data base was developed by the U.S. Geological Survey in conjunction with numerous Federal, State, and local agencies. It is organized by the major river basins of the United States.

# APPENDIX

## DATA COLLECTION FORMS

Exhibit 1. National Fisheries Survey
Data Collection Form

OMB No. 2000-0410
Approval Expires 10/31/83

# NATIONAL FISHERIES SURVEY

**U.S. Fish and Wildlife Service**
**Ft. Collins, Colorado**

**U.S. Environmental Protection Agency**
**Washington, D.C.**

**Engineering-Science, Inc.**

If you have any questions or need additional information concerning this questionnaire, please call the National Fisheries Survey toll-free number 1-800-525-2041. In Colorado, call 1-455-4427.

The reach described above was selected by a statistical sampling procedure. This reach is highlighted on the map on the following page for your reference when answering the questions.

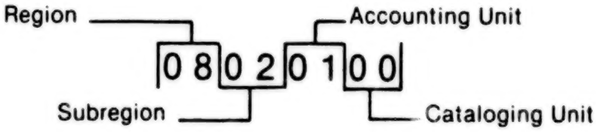
---

OFFICE USE ONLY

| | |
|---|---|
| FR________ | FWSR________ |
| FEd________ | KP________ |
| DR________ | 2ED________ |
| DEd________ | DEd________ |

Exhibit 1. (continued)

### Hydrologic Unit Code



LEGEND

- ● County seat
- ○ City, town, or village
- ✈ Scheduled service airport

## INTRODUCTION

This questionnaire is part of a combined U.S. Fish and Wildlife Service (FWS) and U.S. Environmental Protection Agency (EPA) effort to understand better the biological conditions of the nation's waters and to initiate the first nationwide fisheries data base. You have been selected to participate in the study because of your knowledge and expertise in the field of fisheries biology especially for the reach identified in this questionnaire.

The reach highlighted on the map was randomly selected from a national list of reaches contained in the EPA River Reach File. This file will also serve as the framework for the FWS fisheries data base.

The questions asked of you in this questionnaire were developed jointly by the FWS and the EPA, and were finalized based upon a pretest of the questionnaire conducted in the Fall of 1981. The principal focus of the questionnaire is on sport fish; this is not because sport fish are the only contributors to the value of the reach, but because the majority of available fisheries information concerns these species, and their presence or absence generally indicates conditions of prevailing water quality.

Because only a small number of reaches has been selected for this study, the participation of each scientist selected is extremely important. Please answer all questions. The information that you provide will be used only for statistical analysis of fisheries at the national level. You and your agency will receive copies of the final report of this National Fisheries Survey.

Exhibit 1. (continued)

For question 1, please print in the left hand column the scientific names of all species that occur in the reach at any time. Use additional names (e.g., *salmo gairdneri*—steelhead) if necessary to identify exactly the species present. Check or code all columns of the matrix that are applicable to these species. You may base your answer on personal experience through field sampling, discussion with colleagues or professional judgment.

For the purpose of answering this question, the following definitions apply:

- Sport fish: any fish with a legal limit (numbers, weight, or volume) set by your state's fishing regulations.
- Special concern: any fish species that is of particular concern to the state for preservation and management; included are state-listed threatened or endangered species, native species receiving special management attention, and other species of special concern for study and management; excluded are species receiving special management strictly to improve or diversify recreational fishing.
- Federal threatened or endangered species should be so indicated in the columns provided.

1.

**POPULATION CODES**

*A—Presence*

A = Abundant
C = Common
U = Uncommon
R = Rare
E = Expected
X = Unknown

*B—Percentage of Reach with Species*

1, 10, 20, etc.

*C—Lifestage stocked*
(if not stocked, leave blank)

E = Egg
L = Larvae
F = Fingerling
S = Subcatchable
C = Catchable

*D—Frequency of stocking*

1 = Less than once annually
2 = Annually
3 = More than once annually

| | **Check all that apply to the species.** | | | | | | | | | | | | | **Refer to population codes in box at left.** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Fish Classes** | | | | | | | **Reach Description or Use** | | | | | | **Population** | | | |
| | | | | | | | | | | | | | | **A** | **B** | **C** | **D** |
| List the genus/species/subspecies, race, etc., for all fish species. | Sport | Anadromous | Endangered (Federal) | Threatened (Federal) | Special concern (State) | Commercial | Nonsport | Year round resident | Spawn elsewhere | Spawn and hatch | Nursery | Migration route | Over winter | Presence | Percentage of reach with species | Lifestage stocked | Frequency of stocking |
| 1. | | | | | | | | | | | | | | | | | |
| 2. | | | | | | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | | | | | |
| 11. | | | | | | | | | | | | | | | | | |

If you need more lines to complete the species list, use the back of the last page.

Exhibit 1. (continued)

Question 2 is concerned with the type of information you have available to complete this questionnaire. For the purpose of completing these questions, the following definitions apply:

- Qualitative sampling: this includes visual reconnaissance surveys and techniques which indicate only a species' presence or absence.
- Quantitative sampling: this includes techniques which produce numerical data in the form of population and productivity estimates, relative abundance ratings, biomass estimates, nest or redd counts, etc.

2. Has fish sampling occurred within this reach? CIRCLE ONE NUMBER

Yes, definitely . . . . . . . . . . . 1
Yes, suspected . . . . . . . . . . . 2 → ANSWER A
Doubtful . . . . . . . . . . . . . . . . 3
No, definitely . . . . . . . . . . . . 4 → ANSWER B
Unknown . . . . . . . . . . . . . . . 5

IF SAMPLING OCCURRED (YES, DEFINITELY OR SUSPECTED)

A. List the year(s) of sampling for each type of survey within this reach.

Qualitative ______________________________

Quantitative ______________________________

IF REACH WAS NOT SAMPLED (NO, DEFINITELY OR DOUBTFUL)

B. Has fish sampling occurred within the cataloging unit? CIRCLE ONE NUMBER

Yes, definitely . . . . . . . . . . . 1
Yes, suspected . . . . . . . . . . . 2 → ANSWER C
Doubtful . . . . . . . . . . . . . . . . 3
No, definitely . . . . . . . . . . . . 4 → GO TO Q. 3
Unknown . . . . . . . . . . . . . . . 5

IF SAMPLING OCCURRED (YES, DEFINITELY OR SUSPECTED)

C. List the year(s) of sampling for each type of survey within this cataloging unit.

Qualitative ______________________________

Quantitative ______________________________

3. Check the months the reach has water usable as fish habitat during a normal water year.

| All year | J | F | M | A | M | J | J | A | S | O | N | D | None |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Exhibit 1. (continued)

Question 4 concerns adverse conditions that may be affecting fish in the reach. Note that natural conditions are included in the tables. The tables should be completed one at a time. For example, if a reach is dammed and several adverse conditions result, each table (water quality, water quantity, usable habitat, fish community) should be completed as a unit. If the dam is causing gas supersaturation in the reach, #6 and #46 should be checked; if the dam blocks fish access to spawning gravel upstream, #27 and #71 should be checked. Check "other" only when necessary to explain reach conditions, keep explanations brief.

4. Is the survival, productivity, or use of the fish community being adversely affected by natural or man-made conditions in the reach? CIRCLE ONE NUMBER

Yes, definitely . . . . . . . . . . . 1 ⎤
Yes, suspected . . . . . . . . . . . 2 ⎦ → ANSWER A
Doubtful . . . . . . . . . . . . . . . . 3 ⎤
No, definitely . . . . . . . . . . . . 4 ⎥ → GO TO Q. 5
Unknown . . . . . . . . . . . . . . . 5 ⎦

IF YES (DEFINITELY OR SUSPECTED):

A. Please complete the following tables by checking appropriate factors and sources. If possible, indicate if the factors and sources are of major or minor concern.

**TABLE I.**

**WATER QUALITY**

Check all applicable categories and circle 1 (Major) or 2 (Minor) in each category checked.

**A. LIMITING FACTOR**

| | Major | Minor |
|---|---|---|
| 1___Temperature too high | 1 | 2 |
| 2___Temperature too low | 1 | 2 |
| 3___Turbidity | 1 | 2 |
| 4___Salinity | 1 | 2 |
| 5___Dissolved oxygen | 1 | 2 |
| 6___Gas supersaturation | 1 | 2 |
| 7___pH too acidic | 1 | 2 |
| 8___pH too basic | 1 | 2 |
| 9___Nutrient deficiency | 1 | 2 |
| 10___Nutrient surplus | 1 | 2 |
| 11___Toxic substances | 1 | 2 |
| 12___Other (specify below) | | |
| ________________________ | 1 | 2 |

**B. PROBABLE SOURCE**

| | Major | Minor |
|---|---|---|
| 39___Primarily upstream | 1 | 2 |
| 40___Within reach | 1 | 2 |
| 41___Point source discharge | 1 | 2 |
| 42___Industrial | 1 | 2 |
| 43___Municipal | 1 | 2 |
| 44___Combined sewer | 1 | 2 |
| 45___Mining | 1 | 2 |
| 46___Dam release | 1 | 2 |
| 47___Nonpoint source discharge | 1 | 2 |
| 48___Individual sewage disposal | 1 | 2 |
| 49___Urban runoff | 1 | 2 |
| 50___Landfill leachate | 1 | 2 |
| 51___Construction | 1 | 2 |
| 52___Agriculture | 1 | 2 |
| 53___Feedlot | 1 | 2 |
| 54___Silviculture/logging | 1 | 2 |
| 55___Mining | 1 | 2 |
| 56___Natural | 1 | 2 |
| 57___Unknown | 1 | 2 |
| 58___Other (specify below) | | |
| ________________________ | 1 | 2 |

Exhibit 1. (continued)

## TABLE II.

## WATER QUANTITY

Check all applicable categories and circle 1 (Major) or 2 (Minor) in each category checked.

### C. LIMITING FACTOR

| | Major | Minor |
|---|---|---|
| 13___Below optimum flows | 1 | 2 |
| 14___Above optimum flows | 1 | 2 |
| 15___Loss of flushing flows | 1 | 2 |
| 16___Excessive flow fluctuation | 1 | 2 |
| 17___Occasional low flow | 1 | 2 |
| 18___Other (specify below) | | |
| ______________________ | 1 | 2 |

### D. PROBABLE SOURCE

| | Major | Minor |
|---|---|---|
| 59___Dam (power) | 1 | 2 |
| 60___Dam (flood control) | 1 | 2 |
| 61___Dam (storage) | 1 | 2 |
| 62___Diversion (agriculture) | 1 | 2 |
| 63___Diversion (municipal) | 1 | 2 |
| 64___Diversion (industrial) | 1 | 2 |
| 65___Natural | 1 | 2 |
| 66___Other (specify below) | | |
| ______________________ | 1 | 2 |

## TABLE III.

## USABLE HABITAT

Check all applicable categories and circle 1 (Major) or 2 (Minor) in each category checked.

### E. LIMITING FACTOR

| | Major | Minor |
|---|---|---|
| 19___Adult/juvenile habitat | 1 | 2 |
| 20___Pools | 1 | 2 |
| 21___Riffles | 1 | 2 |
| 22___Undercut banks | 1 | 2 |
| 23___Boulders | 1 | 2 |
| 24___Snags | 1 | 2 |
| 25___Overhead cover | 1 | 2 |
| 26___Egg/larvae habitat | 1 | 2 |
| 27___Gravel | 1 | 2 |
| 28___Plants, plant debris | 1 | 2 |
| 29___Other (specify below) | | |
| ______________________ | 1 | 2 |

### F. PROBABLE CAUSE

| | Major | Minor |
|---|---|---|
| 67___Excessive siltation | 1 | 2 |
| 68___Bank erosion/sloughing | 1 | 2 |
| 69___Channelization | 1 | 2 |
| 70___Other channel modifications | 1 | 2 |
| 71___Migration blockage | 1 | 2 |
| 72___Natural | 1 | 2 |
| 73___Unknown | 1 | 2 |
| 74___Other (specify below) | | |
| ______________________ | 1 | 2 |

## TABLE IV.

## FISH COMMUNITY

Check all applicable categories and circle 1 (Major) or 2 (Minor) in each category checked.

### G. LIMITING FACTOR

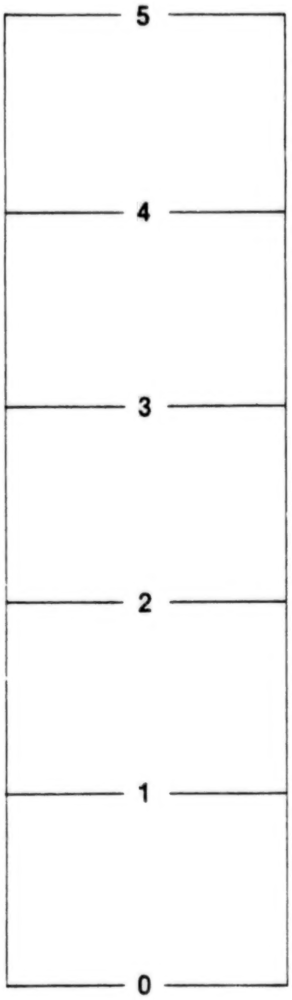
| | Major | Minor |
|---|---|---|
| 30___Fish kills | 1 | 2 |
| 31___Contamination | 1 | 2 |
| 32___Diseases/parasites | 1 | 2 |
| 33___Tumors/lesions | 1 | 2 |
| 34___Overharvest | 1 | 2 |
| 35___Poaching | 1 | 2 |
| 36___Underharvest | 1 | 2 |
| 37___Fish stocking | 1 | 2 |
| 38___Other (specify below) | | |
| ______________________ | 1 | 2 |

### H. PROBABLE SOURCE

| | Major | Minor |
|---|---|---|
| 75___Heavy metals | 1 | 2 |
| 76___Pesticides | 1 | 2 |
| 77___Other noxious/toxic substances | 1 | 2 |
| 78___Crowding | 1 | 2 |
| 79___Other stress | 1 | 2 |
| 80___Natural | 1 | 2 |
| 81___Unknown | 1 | 2 |
| 82___Other (specify below) | | |
| ______________________ | 1 | 2 |

Exhibit 1. (continued)

The next few questions are a subjective but necessary part of this survey. To provide some standardization for response, a "ladder" is shown below describing the spectrum of conditions that could exist in an aquatic ecosystem in terms of the fish community. At the top of the ladder is the ideal situation of maximum ability to support a fish community of high interest, i.e., a community of sport fish or other species of special concern. The bottom of the ladder represents a reach that is incapable of supporting any fish community. Please use this ladder as a reference in answering questions 5, 6, 7, 8, and 9.



5 The reach exhibits a maximum ability to support a community of sport fish, species of special concern, or both.

2 The reach exhibits a minimum ability to support a community of sport fish, species of special concern, or both.

1 The reach exhibits an ability to support a nonsport fish population only.

0 The reach has no ability to support any fish population.

Exhibit 1. (continued)

USE THIS PAGE ONLY IF YOU NEED TO LIST MORE THAN 11 SPECIES OF FISH IN QUESTION 1.

**POPULATION CODES**

***A – Presence***

A = Abundant
C = Common
U = Uncommon
R = Rare
E = Expected
X = Unknown

***B – Percentage of Reach with Species***

1, 10, 20, etc.

***C – Lifestage stocked***
**(if not stocked, leave blank)**

E = Egg
L = Larvae
F = Fingerling
S = Subcatchable
C = Catchable

***D – Frequency of stocking***

1 = Less than once annually
2 = Annually
3 = More than once annually

| | **Check all that apply to the species.** | | | | | | | | | | | | | **Refer to population codes in box at left.** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Fish Classes** | | | | | | | **Reach Description or Use** | | | | | | **Population** | | | |
| | | | | | | | | | | | | | | **A** | **B** | **C** | **D** |
| List the genus/species/subspecies, race, etc., for all fish species. | Sport | Anadromous | Endangered (Federal) | Threatened (Federal) | Special concern (State) | Commercial | Nonsport | Year round resident | Spawn elsewhere | Spawn and hatch | Nursery | Migration route | Over winter | Presence | Percentage of reach with species | Lifestage stocked | Frequency of stocking |
| 12. ______ | | | | | | | | | | | | | | | | | |
| 13. ______ | | | | | | | | | | | | | | | | | |
| 14. ______ | | | | | | | | | | | | | | | | | |
| 15. ______ | | | | | | | | | | | | | | | | | |
| 16. ______ | | | | | | | | | | | | | | | | | |

Exhibit 1. (continued)

CHECK ONE BOX FOR EACH QUESTION

5. Using the scale shown on the opposite page, how would you rank the current conditions of the reach?

| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |

6. Again using this scale, how would you rank the conditions of the reach five years ago?

| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |

7. If present trends in the reach continue, how will it rank five years from now?

| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |

8. Should the man-caused limiting factors (if previously indicated in question 4A) be eliminated or controlled, how will the reach rank five years from now?

| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |

9. Considering, as a standard, a reach in the same or adjacent cataloging unit with the greatest ability to support sport fish, how would you rate that reach on the scale?

| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |

Exhibit 1. (continued)

## RESPONDENT IDENTIFICATION

(to be filled out by the person who completed the questionnaire)*

Name ____________________

State and Agency ____________________

Department/Division ____________________

Title ____________________

Years in this position ____________________

Years in the field of fisheries ____________________

Years familiar with this river basin ____________________

Present mailing address:

Room/Building No. ____________________ P.O. Box ____________________

Street ____________________

City and State ____________________

Zip Code ____________________ Telephone No. ____________________

*Please list the names of any additional people who assisted in completing the questionnaire.

____________________

____________________

____________________

____________________

____________________

Please return this questionnaire in the enclosed, self addressed, stamped envelope to:

Exhibit 2. BIA/Hoopa Valley Indian Reservation
Data Collection Form

## RIVER REACH FISHERY FILE
## INFORMATION FORM

Respondent(s)________________________________________

________________________________________

Reach Identification

River name ____________________________________

Cataloging unit number ____________________________

Reach number ___________________________________

Reach length (miles) ______________________________

Upper reach boundary (with river mile index)________________

_______________________________________________

_______________________________________________

Lower reach boundary (with river mile index)________________

_______________________________________________

_______________________________________________

Office use only: receipt contro

Exhibit 2. (continued)

## INTRODUCTION

This questionnaire is part of a combined effort sponsored by the U.S. Bureau of Indian Affairs and conducted by the U.S. Fish and Wildlife Service (FWS). The information obtained will be used to better understand the fisheries in the area of the Hoopa Valley Indian Reservation and to establish a fisheries information database for the Reservation. You have been selected to participate in the study because of your knowledge and expertise in the field of fisheries biology especially for the reach identified on the front of this questionnaire.

The reach described on the previous page is numbered for inclusion in the River Reach File, a nationwide system for water data coordination developed by FWS and the Environmental Protection Agency (EPA). The File will serve as a framework for the fisheries information database and will provide an interface for retrieving and comparing other water-related data. The questions asked of you on this questionnaire were developed jointly by FWS and EPA for the River Reach File with some expansion of questions specifically for this survey.

Because information is needed for all reaches in the survey, the complete participation of each scientist selected is extremely important. PLEASE ANSWER ALL QUESTIONS. Refer to the completed, sample questionnaire before continuing with the next section. You and your agency will receive copies of all final products resulting from this survey.

## QUESTIONS

Question 1 involves the next three pages (nos. 3, 4, and 5). The first page (p. 3) is a species list; print the common and scientific names of all species that occur in the reach at any time. Use additional identifiers (e.g., winter race, fall race, etc.) if necessary to exactly identify the species present. On page 4, complete all columns which are applicable to those species using the species number from the species list as a cross-reference. For the spawning, nursery, and migration route columns, fill in the number of the month when these reach uses begin and end, if applicable. The third page (p. 5) is used ONLY if additional, sampling data are available to expand on the answers for the matrix columns concerning peak abundance and hatchery supports (marked with a +). Refer to the sample questionnaire for additional explanation.

You may base your answers on personal experience through field sampling, discussion with colleagues or professional judgment. For the purpose of answering the first question, the following definitions apply:

- SPORT FISH: Any fish species with a legal bag limit (numbers, weight, or volume) set by your State's fishing regulations.

- SPECIAL CONCERN: Any fish species that is of particular concern to the State for preservation management; included are State-listed threatened or endangered species, native species receiving special management attention, and other species of special concern for study and management; excluded are Federally listed threatened or endangered species and species receiving special management strictly to improve or diversify recreational fishing.

Exhibit 2. (continued)

## SPECIES LIST

| | Common Name with race, etc. | Scientific Name with subspecies, etc. |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
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| 16. | | |
| 17. | | |
| 18. | | |
| 19. | | |
| 20. | | |

Exhibit 2. (continued)

| | AGE GROUP | | | | FISH CLASSES | | | | | | | POPULATION | | | REACH USES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species number --from previous page | young-of-year | juvenile | adult | all | sport | anadromous | endangered (Fed) | threatened (Fed) | special concern | commercial | nonsport | peak abundance* (+) | part of reach expected to support species** | hatchery supports*** (+) | year-round resident | resident--spawns elsewhere | overwinter | spawning<br>starting month<br>ending month | nursery<br>starting month<br>ending month | migration route<br>starting month<br>ending month | unknown |
| | | | | | | | | | | | | | | | | | | | | | |
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If you need more lines to complete this form, use a duplicate page.

* For peak abundance, use A (abundant), C (common), U (uncommon), R (rare), E (expected), X (unknown) -- see chart on back of Respondent Identification Page for ratings; (+) indicates sample data, if available, should be placed in matrix on next page.

** Use A (all) or U (upper), M (middle), L (lower) and 25%, 33%, 50%, 67%, or 75%.

*** For stocked species, indicate life stage with E (egg), L (larvae), F (fingerling), S (subcatchable), C (catchable) and frequency of stocking with 1 (less than once annually), 2 (annually), 3 (more than once annually); (+) indicates sample data, if available, should be placed in matrix on next page.

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Exhibit 2. (continued)

ABUNDANCE MATRIX

| Species number | Peak no. of fish sampled | Number of river miles sampled | Sample day mo/d/yr | Total no. of fish sampled (same year) | Total no. of samples | Range of sample days mo/d/yr |
|---|---|---|---|---|---|---|
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HATCHERY SUPPORT MATRIX

| Hatchery name and State | Species number | Number of fish stocked -- average for last five years | | | % returns-- five-year average | Total no. stocked last season | Year stocked |
|---|---|---|---|---|---|---|---|
| | | young-of-year | juveniles | other | | | |
| | | | | | | | |
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Exhibit 2. (continued)

2a. Is the reach used during ceremonial fishing rites?
1_____ Yes 2_____ No 3_____ Unknown

b. If yes, list the date(s) the rites occur on the reach:

______________________________________________

3. Check the months the reach has water useable as fish habitat during a normal water year:

| None | J | F | M | A | M | J | J | A | S | O | N | D | All yr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

4a. What is the range of gradient (%) for the reach? _______ % to _______ %

b. What is the average gradient of the reach? _______________ %

5a. What is the range of pool/riffle ratios for the reach?

_______ / _______ to _______ / _______

b. What is the average pool/riffle ratio for the reach? __________

6. Describe the substrate of the reach (indicate type, particle size, and percent composition, where available):

______________________________________________

______________________________________________

7. Describe the bank cover (forested, brush and grass, exposed) and % of each:

______________________________________________

______________________________________________

The next question concerns adverse conditions that may be affecting fish in the reach. Note that natural conditions are included in the list. The checklist should be completed one major group at a time. For example, if a reach is dammed and several adverse conditions result, each category (Water Quality, Water Quantity, Useable Habitat, Fish Community) should be completed as a unit. If the dam is causing gas supersaturation in the reach, #6 and #44 should be checked; if the dam blocks fish access to spawning gravel upstream, #25 and #68 should be checked. Check the "other" categories only when necessary to explain reach conditions; keep explanations at the bottom of the page short.

8a. Is the survival, productivity, or use of the fish community being adversely affected by natural or man-made conditions in the reach?
1_____ Yes (definite) 3_____ No (definite) 5_____ Unknown
2_____ Suspected 5_____ Doubtful

b. If yes (or suspected), please complete the following table by checking appropriate factors and sources. If possible, indicate if the factors and sources are of major or minor concern.

Exhibit 2. (continued)

## I. WATER QUALITY

### A. FACTOR

| | a. Major | b. Minor |
|---|---|---|
| 1____temperature--too high | ____ | ____ |
| 2____temperature--too low | ____ | ____ |
| 3____turbidity | ____ | ____ |
| 4____salinity | ____ | ____ |
| 5____dissolved oxygen | ____ | ____ |
| 6____gas supersaturation | ____ | ____ |
| 7____pH--too acidic | ____ | ____ |
| 8____pH--too basic | ____ | ____ |
| 9____nutrient deficiency | ____ | ____ |
| 10____nutrient surplus | ____ | ____ |
| 11____other (complete below) | ____ | ____ |

### B. PROBABLE SOURCE

| | a. Major | b. Minor |
|---|---|---|
| 37____primarily upstream | ____ | ____ |
| 38____within reach | ____ | ____ |
| 39____point source discharge | ____ | ____ |
| 40____industrial | ____ | ____ |
| 41____municipal | ____ | ____ |
| 42____combined sewer | ____ | ____ |
| 43____mining | ____ | ____ |
| 44____dam release | ____ | ____ |
| 45____nonpoint source discharge | ____ | ____ |
| 46____individual sewage | ____ | ____ |
| 47____urban runoff | ____ | ____ |
| 48____landfill leachate | ____ | ____ |
| 49____construction | ____ | ____ |
| 50____agricultural | ____ | ____ |
| 51____feedlot | ____ | ____ |
| 52____silviculture/logging | ____ | ____ |
| 53____natural | ____ | ____ |
| 54____unknown | ____ | ____ |
| 55____other (complete below) | ____ | ____ |

## II. WATER QUANTITY

### C. FACTOR

| | a. Major | b. Minor |
|---|---|---|
| 12____below optimum flows | ____ | ____ |
| 13____above optimum flows | ____ | ____ |
| 14____loss of flushing flows | ____ | ____ |
| 15____excessive flow fluctuation | | |
| 16____occasional no flow | ____ | ____ |
| 17____other (complete below) | ____ | ____ |

### D. PROBABLE SOURCE

| | a. Major | b. Minor |
|---|---|---|
| 56____dam--power | ____ | ____ |
| 57____dam--flood control | ____ | ____ |
| 58____dam--storage | ____ | ____ |
| 59____diversion--agriculture * | ____ | ____ |
| 60____diversion--municipal * | ____ | ____ |
| 61____diversion--industrial * | ____ | ____ |
| 62____natural | ____ | ____ |
| 63____other (complete below) | ____ | ____ |

## III. USEABLE HABITAT

### E. HABITAT LACKING

| | a. Major | b. Minor |
|---|---|---|
| 18____adult/juvenile | | |
| 19____pools | ____ | ____ |
| 20____riffles | ____ | ____ |
| 21____undercut banks | ____ | ____ |
| 22____boulders | ____ | ____ |
| 23____snags | ____ | ____ |
| 24____egg/larvae | | |
| 25____gravel | ____ | ____ |
| 26____plants/plant debris | ____ | ____ |
| 27____other (complete below) | ____ | ____ |

### F. PROBABLE CAUSE

| | a. Major | b. Minor |
|---|---|---|
| 64____excessive siltation | ____ | ____ |
| 65____bank erosion/sloughing | ____ | ____ |
| 66____channelization | ____ | ____ |
| 67____other channel modifications | | |
| 68____migration blockage * | ____ | ____ |
| 69____natural | ____ | ____ |
| 70____unknown | ____ | ____ |
| 71____other (complete below) | ____ | ____ |

## IV. FISH COMMUNITY

### G. FACTOR

| | a. Major | b. Minor |
|---|---|---|
| 28____fish kills | ____ | ____ |
| 29____contamination | ____ | ____ |
| 30____diseases/parasites | ____ | ____ |
| 31____tumors/lesions | ____ | ____ |
| 32____overharvest | ____ | ____ |
| 33____poaching | ____ | ____ |
| 34____underharvest | ____ | ____ |
| 35____fish stocking | ____ | ____ |
| 36____other (complete below) | ____ | ____ |

### H. PROBABLE CAUSE

| | a. Major | b. Minor |
|---|---|---|
| 72____heavy metals | ____ | ____ |
| 73____pesticides | ____ | ____ |
| 74____other noxious/toxic substances | | |
| 75____crowding | ____ | ____ |
| 76____other stress | ____ | ____ |
| 77____natural | ____ | ____ |
| 78____unknown | ____ | ____ |
| 79____other (complete below) | ____ | ____ |

Use the following two lines (maximum) to complete statements marked "other:"

________________________________________

________________________________________

* Complete on next page.

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Exhibit 2. (continued)

| MIGRATION BLOCKAGE | | | | | | | | | | | | | | | | DIVERSIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Type | | | | | | | | | | | | | | | | Type | | | | | | | | | |
| Location by river mile | log | log and rock | natural falls | natural cascades | man-made dam | man-made culvert | low flow | Height (ft) | Passable | Impassable | Removal priority* | If removed, removal date (mo/d/yr) | Usable upstream spawning habitat (mi) | Cost of removal ($) | Permanence of removal** | Location by river mile | agricultural | municipal | industrial | cfs diverted | % flow diverted | Screened | Unscreened | Correction priority* | Cost of correction ($) | If corrected, correction date (mo/d/yr) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
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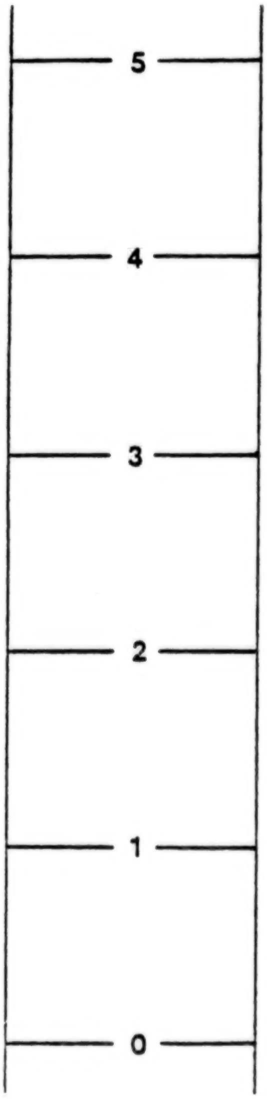
* Priority codes: 1 = removal or correction critical; 2 = necessary; 3 = desirable; 4 = helpful; 5 = not helpful, impossible

** Permanence codes: 1 = permanent removal; 3 = semi-permanent needing removal every 5 to 10 years; 5 = requires annual maintenance

Exhibit 2. (continued)

The next few questions are a highly subjective but necessary part of this survey. To provide some standardization for response, a "ladder" is shown below describing the spectrum of conditions that could exist in an aquatic ecosystem in terms of the fish community. At the top of the ladder is the ideal situation of maximum ability to support a fish community of high interest, i.e., a community of sport fish or other species of special concern. The bottom of the ladder represents a reach that is incapable of supporting any fish community. Please use this ladder as a reference in answering questions 6, 7, 8, and 9.



5 The reach exhibits a maximum ability to support a community of sport fish, species of special concern, or both.

2 The reach exhibits a minimum ability to support a community of sport fish, species of special concern, or both.

1 The reach exhibits an ability to support a nonsport fish population only.

0 The reach has no ability to support ANY fish population.

Exhibit 2. (continued)

9. Using the scale shown on the preceeding page, how would you rank the current conditions of the reach?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 unknown

10. Again using this scale, how would you rank the conditions of the reach five years ago?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 unknown

11. If present trends in the reach continue, how will it rank in five years from now on the scale?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 unknown

12a. If the man-caused limiting factors (previously indicated in question 5b) are eliminated or controlled, what will the reach conditions be in five years?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 unknown

b. If an improvement in conditions is indicated above, please use these lines to indicate the type of modification needed, the priority for implementation (critical, necessary, desirable, helpful), and if the modification is in progress, in planning, or discussion stage only:

________________________________________

________________________________________

________________________________________

The next two questions are concerned with the type of information you had available to complete this questionnaire. The following definitions apply:

- QUALITATIVE SAMPLING: this includes visual reconnaissance surveys and techniques which indicate only a species presence or absence.
- QUANTITATIVE SAMPLING: this includes techniques which produce numerical data in the form of population and productivity estimates, relative abundance ratings, biomass estimates, etc.

13a. Has fish sampling ever occurred within this reach?
1_____ Yes (definite) 3_____ No (definite) 5_____ Unknown
2_____ Suspected 4_____ Doubtful

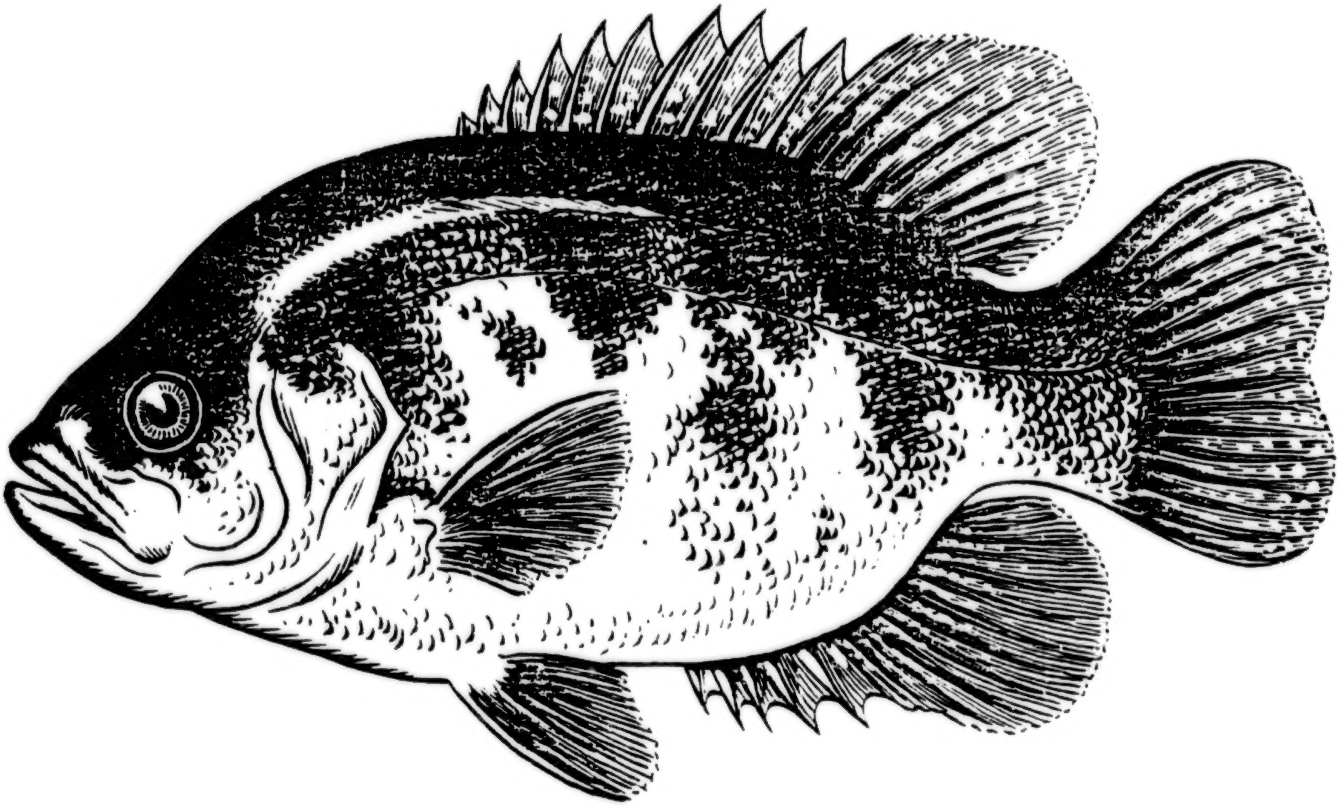
b. If yes (or suspected), list the year(s) of sampling for each type of survey:
qualitative sampling ______________________________
quantitative sampling ______________________________

14a. If the reach has not (or probably not) been sampled, has fish sampling ever occurred within the cataloging unit?
1_____ Yes (definite) 3_____ No (definite) 5_____ Unknown
2_____ Suspected 4_____ Doubtful

b. If yes (or suspected), list the year(s) of sampling for each type of survey:
qualitative sampling ______________________________
quantitative sampling ______________________________

Exhibit 3. Tennessee RRFIS Application
Data Collection Form

# TENNESSEE AQUATIC DATABASE SYSTEM



Tennessee Wildlife Resources Agency

Nashville, Tennessee

Tennessee Technological University
Cooperative Fishery Research Unit
Cookeville, Tennessee

WR-0489(V83)

Exhibit 3. (continued)

## TENNESSEE AQUATIC DATABASE SYSTEM

United States Fish and Wildlife Service
Western Energy & Land Use Team
Fort Collins, Colorado

Tennessee Wildlife Resources Agency
Nashville, Tennessee

Tennessee Cooperative Fishery Research Unit
Tennessee Technological University
Cockeville, Tennessee

If you have any questions or need information concerning this questionnaire please call the Tennessee Cooperative Fishery Research Unit, telephone number (615) 528-3094

Tennessee Cooperative Fishery Research Unit
Tennessee Technological University
Biology Department,Box 5063
Cookeville, Tennessee 38501

Exhibit 3. (continued)

## INTRODUCTION

This questionnaire is part of a combined Tennessee Wildlife Resources Agency (TWRA), Tennessee Cooperative Fishery Research Unit (TCFRU) and United States Fish and Wildlife Service-Western Energy and Land Use Team (USFWS-WELUT) effort to better understand the state's waters and the physical, chemical and biological conditions of these waters. When completed, this survey will provide an extensive database which will aide in the management of Tennessee's waters.

## DEFINITIONS

| | |
|---|---|
| Reach: | a segment of a stream artificially defined as lying between two confluences, or from the mouth of the stream upstream to its first confluence |
| Qualitative Sample: | this includes visual reconnaissance surveys and techniques which indicate only a species presence or absence |
| Quantitative Sample: | this includes techniques which produces numerical data in the form of population and productivity estimates, relative abundance ratings, biomass, estimates, etc. |
| Priority Mollusks: | those mollusks classified as endangered, threatened, in need of management, or special concern by state and/or federal agencies |
| Priority Aquatic Species: | any species that is listed as endangered, threatened, in need of management, or special concern by state and/or federal agencies |
| THR: | Tennessee Heritage Program |
| Experimental Population: | a priority species that has been relocated for the purpose of establishing a new population |
| Relative Abundance: | the percentage an organism is found in any given sample (e.g. if a species was collected 25 times in a total sample of 75, it would be C common, Appendix A6) |
| Benthic Macro-Inverterbrate: | animals that are large enough to be seen by an unaided eye and can retained by a U.S. Standard No. 30 sieve and lives at least part of its life cycle within or upon available substrate in a body of water |
| River Mile: | that point along a natural river course that is a given distance (miles) from the mouth of the river upstream to that point; river miles are listed on USCOE navigational maps and/or USGS 7½' guadrangle maps |

Exhibit 3. (continued)

## REACH DESCRIPTION

Stream/River Name:____________________________________________

River System:______________________________________________

Catalog Unit:______________________________________________

Reach Number:______________________________________________

RMI (daughter reach qualifer):___________________________________

Reach Length (Miles):_________________________________________

| Joining Reaches | Reach Number | RMI | Catalog Unit |
|---|---|---|---|
| Up-reach 1 | __________ | ____ | __________ |
| Up-reach 2 | __________ | ____ | __________ |
| Down-reach 1 | __________ | ____ | __________ |
| Down-reach 2 | __________ | ____ | __________ |

Brief narrative description of upstream(upper) reach boundary:

____________________________________________________________

Brief narrative description of downstream(down) reach boundary:

____________________________________________________________

Map Scale: (please circle)     1:500,000     1:250,000     1:24,000

County:_____________________________________________________

Type of System: (please circle)

| Stream | Natural Lake | Oxbow Lake | Small Reservoir<br>(less than 500 Ac) | Large Reservoir<br>(greater than 500 Ac) |
|---|---|---|---|---|

Data are (identical) or (very similiar) to that reach________,RMI________

Give any additional information that might aide in locating this reach:

____________________________________________________________

____________________________________________________________

____________________________________________________________

Exhibit 3. (continued)

List any EPA STORET Station Number(s):

____________________ / ____________________ / ____________________

List any USGS WATSTORE Station Number(s):

____________________ / ____________________ / ____________________

List any Archaeological Sites adjacent to the reach:

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

## GENERAL INSTRUCTIONS

Please complete the following questions utilizing the most recent literature available, agency's records and your personnal observations concerning this reach. Where indicated, please record the source of information that you utilized in completing this questionnaire. All columns designated by an asterisk(*) indicates that column should be completed using the appropriate codes which can be found in the appendix. All appendices are indicated on the appropriate question. Please complete the data control information sheet under the compiler's name section.

Exhibit 3. (continued)

Question 1.

1a. Has fish sampling occurred within this reach? (Please circle)

| | | |
|---|---|---|
| Yes, qualitative . . . . | 1 | Go to Q1b. |
| Yes, quantitative . . . . | 2 | |
| Doubtful . . . . . . | 3 | Go to Q2. |
| No . . . . . . . | 4 | |
| Unknown . . . . . . | 5 | |

1b. List the year, month, day (if possible) that the most current collection was made?

__ __ __ __ __ __ (leave unknowns blank)

Y M D

1c. List the location of that collection as stated by the literature source.

________________________________________

________________________________________

________________________________________

1d. List the method of sampling code(s) from Appendix A12 for the most current collection.

____ ____ ____ ____ ____ ____

1e. List the literature cited reference number(s) from the attached sheet.

____ ____ ____ ____ ____ ____

Question 2.

Circle the month(s) the reach has water usable as fish habitat during a normal water year.

All J F M A M J J A S O N D None

Exhibit 3. (continued)

Question 3.

3a. Has priority mollusk sampling occurred within this reach? (Please Circle)

| | | |
|---|---|---|
| Yes, qualitative . . . . . | 1 | Go to Q3b. |
| Yes, quantitative . . . . . | 2 | |
| Doubtful . . . . . . . | 3 | Go to Q4. |
| No . . . . . . . . | 4 | |
| Unknown . . . . . . . | 5 | |

3b. List the year, month, day (if possible) that the most current collection was made.

__ __    __ __    __ __ (leave unknowns blank)

Y    M    D

3c. List the location of that collection as stated by the literature source.

________________________________________

________________________________________

________________________________________

3d. List the method of sampling code(s) from Appendix A12 for the most current collection.

____ ____ ____ ____ ____ ____

3e. List the literature cited reference number(s) from the attached sheet.

____ ____ ____ ____ ____ ____

Exhibit 3. (continued)

Question 4.

Table 1 consists of a set of questions that describes fish, priority mollusks and other aquatic priority species that inhabitat this reach.

Please print in the left column the species code, or scientific and common name of all fish, priority mollusks and other aquatic priority species found in this reach and stated in the most current literature (Question 1e,3e). Use additional names (e.g. Esox masquinongy ohioensis, Ohio River Muskellunge) if necessary to identify exactly the species present. Code all other applicable columns with the appropriate code (all columns designated by an asterisk*). Please leave all unknown or non-applicable boxes blank. Use only the most current literature source.

| | |
|---|---|
| Fish Status . . . . . . . . . | Table A1. |
| Priority Mollusks Status . . . . . . . | Table A2. |
| Other Aquatic Priority Species Status . . . . . | Table A3. |
| Species Codes . . . . . . . . . | Tables A1,A2,A3 |
| Status Codes . . . . . . . . . | Appendix A4 |
| Reach Usage Codes . . . . . . . . . | Appendix A5 |
| Population Codes . . . . . . . . . | Appendix A6 |

Exhibit 3. (continued)

Table 1. Species matrix.

| | STATUS<br>Legal Status | | | | | | | REACH USAGE | | | | POPN. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genus/Species/Subspecies; Common Name; Species Number | Zoological* | Legal (TWRA)* | Federal* | State (TWRA)* | THP* | Management* | Historical* | Seasonal* | Habitat Usage* | % of Reach Utilized | Location within Reach* | Abundance* | Number of Indiv. for Priority Spec. |
| | | | | | | | | | | | | | |
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Exhibit 3. (continued)

Question 5.

5a. Has benthic macroinvertebrate (excluding priority mollusk) sampling occurred within this reach? (Please circle)

| | | |
|---|---|---|
| Yes, qualitative . . . . | 1 | Go to Q5b. |
| Yes, quantitative . . . . | 2 | |
| Doubtful . . . . . . | 3 | Go to Q7. |
| No . . . . . . . | 4 | |
| Unknown . . . . . . | 5 | |

5b. List the year, month, day (if possible that the most current collection was made.

___ ___ ___ ___ ___ ___ (leave unknowns blank)

Y M D

5c. List the location of that collection as stated by the literature source.

______________________________

______________________________

______________________________

5d. List the method of sampling code(s) from Appendix A12 for the most current collection.

_____ _____ _____ _____ _____ _____

5e. List the literature cited reference number(s) from the attached sheet.

_____ _____ _____ _____ _____ _____

Exhibit 3. (continued)

Question 6.

Table 2 consists of a set of questions which describes benthic macroinvertebrate (excluding priority mollusks) that inhabit this reach. The table has been designed so that the lowest taxonomic level is the family (subfamily for chironomids). All lower taxonomic levels of interest can be determined by consulting the literature listed in Question 5e and the attached sheet.

Please print in the left hand column the family number or the family/subfamily name (e.g. Baetidae) of benthic macroinvertebrates (excluding priority mollusks) found in this reach and stated in the most current literature. Please check (✓) the dominant family/subfamily for taxa listed in the table. The dominant family/subfamily is defined as the family/subfamily with the greatest numerical abundance. The number of genera applies to each individual family/subfamily collectively for all quantitative and qualitative samples during any given sampling period. Numbers for relative abundance and family/subfamily numbers can be found in the appendix. A total for each number of genera, Shannon-Weaver Diversity Index, Evenness Index and the total number of individuals should be completed in the appropriate box (if available). The total number of other families are those that are not listed in the table. Use only the most current literature source.

Relative Abundance Codes . . . Appendix A7.

Family/Subfamily Codes . . . Appendix A8.

Exhibit 3. (continued)

Table 2. Benthic macroinvertebrate(excluding priority mollusks) matrix.

| | QUALITATIVE | | QUANTITATIVE | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Dominant Family | No. of Genera | Dominant Family | No. of Genera | * Relative Abundance | Shannon-Weaver Diversit | Evenness Index | Total No of Indiv. |
| Class Oligochaeta | | | | | | | | |
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| **Order Epmemeroptera** | | | | | | | | |
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| **Order Plecoptera** | | | | | | | | |
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Exhibit 3. (continued)

Table 2. continued.

| | QUALITATIVE | | QUANTITATIVE | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Dominant Family | No. of Genera | Dominant Family | No. of Genera | * Relative Abundance | Shannon-Weaver Diversity | Evenness Index | Total No of Indiv. |
| **Order Plecoptera (continued)** | | | | | | | | |
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| **Order Coleoptera** | | | | | | | | |
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| **Order Megaloptera** | | | | | | | | |
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| **Order Odonata** | | | | | | | | |
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Exhibit 3. (continued)

Table 2. continued.

| | QUALITATIVE | | QUANTITATIVE | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Dominant Family | No. of Genera | Dominant Family | No. of Genera | * Relative Abundance | Shannon-Weaver Diversit | Evenness Index | Total No of Indiv. |
| Order Trichoptera | | | | | | | | |
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| Order Diptera | | | | | | | | |
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Exhibit 3. (continued)

Table 2. continued.

| | QUALITATIVE | | QUANTITATIVE | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Dominant Family | No. of Genera | Dominant Family | No. of Genera | * Relative Abundance | Shannon-Weaver Diversity | Evenness Index | Total No of Indiv. |
| Order Diptera (continued) | | | | | | | | |
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| **Family Chironomidae (subfamily)** | | | | | | | | |
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| Order Amphipoda | | | | | | | | |
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| Order Decapoda | | | | | | | | |
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| **Order Isopoda** | | | | | | | | |
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| **Class Pelecypoda** | | | | | | | | |
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Exhibit 3. (continued)

Table 2. continued.

| | QUALITATIVE | | QUANTITATIVE | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Dominant Family | No. of Genera | Dominant Family | No. of Genera | * Relative Abundance | Shannon-Weaver Diversity | Evenness Index | Total No. of Indiv. |
| Class Gastropoda | | | | | | | | |
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| Total Number of Other Families | | | | | | | | |
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Exhibit 3. (continued)

Question 7.

Has a fish kill occurred within this reach? (Please circle one)

Yes . . . . . . 1 Go to Q8.

No . . . . . . 2 Go to Q9.

Question 8.

Table 3 consists of a set of questions that describes a fish kill. The table is designed as a chronological record of fish kills. Only those fish kills reported by the Tennessee Wildlife Resources Agency are to be included.

Please print the year, month, day as a two digit number (e.g. September 1, 1960 would be 60 09 01). The location should be recorded as river mile. Number of fish killed and the dollar value should be recorded as the appropriate value(#,$). Cause of fish kill and documentation should be coded using the appropriate codes found in the appendix. Documentation is defined as to the cause of the fish kill (e.g. was it known what caused the kill or suspected). Please include any comments.

Cause of Fish Kill Codes . . Appendix A9.

Documentation Codes . . . Appendix A9.

Exhibit 3. (continued)

Table 3. Fish Kill Matrix

| Year | Month | Day | Location | Cause of Fish Kill* | Documentation* | Number of Fish Killed | Dollar Value of Fish | Comments |
|---|---|---|---|---|---|---|---|---|
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Exhibit 3. (continued)

Question 9.

Table 4 consists of a set of questions that describes fish stocking, creel census and scientific sampling or commercial harvest. The table is designed as a chronological record of these activities. Only game or commercial important fish, or mollusk species are to be included. All year, month, day columns should be completed using the appropriate two digit number. The source column should be completed for scientific sampling only utilizing the literature cited reference numbers from the attached sheet. All other columns should be completed with the appropriate code.

| | |
|---|---|
| Species Codes . . . . | Tables A1,A2,A3 |
| Size Class Codes . . . . | Appendix A10. |
| Method of Collection Codes . . | Appendix A11. |

Exhibit 3. (continued)

Table 4. Management Matrix

| Fish Stocking | | | | | | Creel Census | | | | | | Scientific Sampling or Commercial Harvest | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Day | Species* | Number | Size class* | Year | Species | Number/acre | Pounds/acre | Number/hour | Pounds/hour | Year | Month | Species* | Method* | Numbers/acre | Numbers/feet | Pounds/acre | Pounds/year | Source |
| | | | | | | | | | | | | | | | | | | | | |
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Exhibit 3. (continued)

Question 10.

Table 5A and 5B consist of a matrix which describes size class structure of all fish species found in the reach. Species codes are those listed in Table A1. of the appendices. Numbers and pounds of species for each size class should be placed in the proper columns.

Exhibit 3. (continued)

Table 5A. Size class matrix.

| Species Codes | 0-1 inches | | 1-2 inches | | 2-3 inches | | 3-4 inches | | 4-5 inches | | 5-6 inches | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | lbs. | No. | lbs. | No. | lbs. | No. | lbs. | No. | lbs. | No. | lbs. |
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Table 5B. Size class matrix.

| Species Codes | 6-7 inches | | 7-8 inches | | 8-9 inches | | 9-10 inches | | 10-11 inches | | Greater than 11 inches | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Exhibit 3. (continued)

Exhibit 3. continued . . .

Exhibit 3. (continued)

Question 11.

Is the survival, productivity or use of the aquatic biota being adversely affected by manmade or natural conditions in this reach?

| | | |
|---|---|---|
| Yes, definitely . . . . . . . . . . | 1 | Go to Q.11 |
| Yes, suspected . . . . . . . . . . | 2 | |
| Doubtful . . . . . . . . . . . . | 3 | Go to Q.12 |
| Not affected . . . . . . . . . . . | 4 | |
| Unknown . . . . . . . . . . . . | 5 | |

Question 12.

Tables 6, 7, 8, consist of a set of questions that describe the chemical, physical and biological/fish habitats of this reach. The tables are designed so that a cause and affect relationship can be made.

The left hand half of the tables are a list of limiting factors that may be affecting the reach. The right hand half of the table is a list of probable sources/causes that may be attributed to the limiting factors. The column designated as M is for major or minor classification. Major (A) indicates the problem is serious and is severely limiting the aquatic environment. Minor (B) indicates the problem is not severely limiting the aquatic environment and is most likely chronic in nature. (A=Major, B=Minor) The column designated as L is for location and should be indicated as river mile or in the case of probable sources/causes if the problem is upstream by U. If the river mile is not know, but the probable cause/source is within the reach please use W to indicate this. The cause code is the number directly to the left of the individual probable source/cause (Nos. 51-115). More than one cause code can be linked to a limiting factor, but only those cause codes on the same table can be linked to a factor (e.g. codes 51-73 for Table 5, codes 74-94 for Table 6, codes 95-115 for Table 7). Please complete the tables leaving all unknowns or inappropriate boxes blank.

Exhibit 3. (continued)

Table 6. Chemical Habitat

| Limiting Factor | M | L | Cause Code | Probable Source/Cause | M | L |
|---|---|---|---|---|---|---|
| 1. Temperature too high | | | | POINT SOURCE DISCHARGE | | |
| 2. Temperature too low | | | | 51. Industrial | | |
| 3. Turbidity | | | | 52. Municipal | | |
| 4. Salinity | | | | 53. Combined Sewer | | |
| 5. Dissolved Oxygen | | | | 54. Mining | | |
| 6. Gas Supersaturation | | | | 55. Coal Washing | | |
| 7. pH too Acidic | | | | 56. Power Plant | | |
| 8. pH too Basic | | | | 57. Dam Release | | |
| 9. Nutrient Deficiency | | | | 58. Dredge Effluent | | |
| 10. Nutrient Surplus | | | | 59. Other (specify) | | |
| 11. Settable Solids | | | | NONPOINT SOURCE DISCHARGE | | |
| 12. Pesticides | | | | 60. Individual Sewage | | |
| 13. Iron | | | | 61. Urban Runoff | | |
| 14. Manganese | | | | 62. Landfill Leachate | | |
| 15. Sulfate | | | | 63. Construction | | |
| 16. Other Metals | | | | 64. Agriculture | | |
| 17. Toxic Substances | | | | 65. Feedlot | | |
| 18. Other (specify) | | | | 66. Gravel/Sand Removal | | |
| 19. Other (specify) | | | | 67. Oil & Gas Drilling | | |
| | | | | 68. Atmospheric Deposition | | |
| | | | | 69. Excavated Material | | |
| | | | | 70. Natural | | |
| | | | | 71. Unknown | | |
| | | | | 72. Other (specify) | | |
| | | | | 73. Other (specify) | | |
| | | | | | | |

Exhibit 3. (continued)

Table 7. Physical Habitat

| Limiting Factor | M | L | Cause Code | Probable Source/Cause | M | L |
|---|---|---|---|---|---|---|
| 20. Excessive Flow Fluctuation | | | | 74. Dam (cooling) | | |
| 21. Occassional Low Flow | | | | 75. Dam (power) | | |
| 22. Occassional High Flow | | | | 76. Dam (Multi-use) | | |
| 23. Loss of Flushing Flow | | | | 77. Diversion(agriculture) | | |
| 24. Excessive Gradient | | | | 78. Diversion(industrial) | | |
| 25. Low Flow | | | | 79. Diversion (municipal) | | |
| 26. Inadequate Substrate | | | | 80. Channelization | | |
| 27. Pool/Riffle Ratio | | | | 81. Channel Modification | | |
| 28. Instream Debris(excess) | | | | 82. Levies and Weirs | | |
| 29. Aquatic Weeds (excess) | | | | 83. Bank Erosion/Sloughing | | |
| 30. Aquatic Weeds (lack) | | | | 84. Excessive Siltation | | |
| 31. Snags (lack) | | | | 85. Industrial Wastes | | |
| 32. Raparian/Wetland/ Oxbow Zones (lack) | | | | 86. Agricultural Wastes | | |
| 33. Undercut Banks(lack) | | | | 87. Municipal Wastes | | |
| 34. Canopy Cover (lack) | | | | 88. Gravel Dredging | | |
| 35. Other (specify) | | | | 89. Agricultural Practices | | |
| 36. Other (specify) | | | | 90. Construction | | |
| | | | | 91. Natural | | |
| | | | | 92. Unknown | | |
| | | | | 93. Other (specify) | | |
| | | | | 94. Other (specify) | | |

Exhibit 3. (continued)

Table 8. Biological/Fish Habitat

| Limiting Factor | M | L | Cause Code | Probable Source/Cause | M | L |
|---|---|---|---|---|---|---|
| 37. Fish Kills | | | | 95. Heavy Metals | | |
| 38. Introduction of Exotic Species | | | | 96. Pesticides | | |
| 39. Overharvest | | | | 97. Other Toxic Substances | | |
| 40. Underharvest | | | | 98. Siltation | | |
| 41. Illegal Harvest | | | | 99. Temperature | | |
| 42. Disease/Parasite | | | | 100. Municipal Runoff | | |
| 43. Inadequate Food Source | | | | 101. Industrial Runoff | | |
| 44. Contamination | | | | 102. Agricultural Runoff | | |
| 45. Reproductive Failure (spawning habitat) | | | | 103. Agricultural Practices | | |
| 46. Reproductive Failure ( water quality) | | | | 104. Logging | | |
| 47. Loss of canopy cover | | | | 105. Mining | | |
| 48. Unknown | | | | 106. Construction | | |
| 49. Other (specify) | | | | 107. Loss of Wetlands | | |
| 50. Other (specify) | | | | 108. Overcrowding/Stunting | | |
| | | | | 109. Angler Access | | |
| | | | | 110. Poor Fish Mgt. Prac. | | |
| | | | | 111. Other Stress | | |
| | | | | 112. Natural | | |
| | | | | 113. Unknown | | |
| | | | | 114. Other (specify) | | |
| | | | | 115. Other (specify) | | |
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Exhibit 3. (continued)

Question 13.

Please write any other comments you have concerning this reach.

Exhibit 3. (continued)

Hydrologic Unit ________________ River Reach ________________

Literature Cited Reference Section. (Please give a full citation of each source you utilized in completing the survey for this reach).

Code

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

4. ____________________________________________

5. ____________________________________________

6. ____________________________________________

7. ____________________________________________

8. ____________________________________________

Exhibit 3. (continued)

Hydrologic Unit ____________________ River Reach ___ _________

DATA CONTROL INFORMATION

Compiler's Name: ______________________________

Title: ______________________________

Agency: ______________________________

Address: ______________________________

______________________________

______________________________

Telephone: ______________________________

Verifier's Name: ______________________________

Title: ______________________________

Agency: ______________________________

Address: ______________________________

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Telephone: ______________________________

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**REPORT DOCUMENTATION PAGE**

**1. REPORT NO.** Biological Report 85(8)

**2.**

**3. Recipient's Accession No.**

**4. Title and Subtitle**
Guidelines for implementing natural resource information systems: The River Reach Fisheries Information System

**5. Report Date** May 1985

**6.**

**7. Author(s)**
Molly R. Whitworth, Lee S. Ischinger, and Gerald C. Horak

**8. Performing Organization Rept. No.**

**9. Performing Organization Name and Address**
Western Energy and Land Use Team, U.S. Fish and Wildlife Service,
2627 Redwing Road, Fort Collins, CO 80526-2899; and

Technical Government Services, Inc., P.O. Box 9076,
Fort Collins, CO 80525

**10. Project/Task/Work Unit No.**

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(G)

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Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior, Washington, DC 20240

**13. Type of Report & Period Covered**

**14.**

**15. Supplementary Notes**

**16. Abstract (Limit: 200 words)**

The River Reach Fisheries Information System (RRFIS) is an automated computer system that organizes natural resource data. It has been designed to: 1) help monitor the condition of fisheries and aquatic habitat regionally and Nationally; and 2) serve as a site-specific fishery management tool.

The RRFIS provides interactive data base management and geographic information system (GIS) capabilities that can be customized to each user's special needs.

This report provides RRFIS users with a step-by-step guide to designing and implementing a RRFIS for their own resource needs. Applications of the RRFIS are also included. A glossary and appendix provide additional information.

**17. Document Analysis a. Descriptors**

Information systems
Natural resources
Fisheries
Computer systems programs
Manuals

**b. Identifiers/Open-Ended Terms**

Geographic information systems
Data base management

**c. COSATI Field/Group**

**18. Availability Statement**
Release unlimited

**19. Security Class (This Report)** Unclassified

**20. Security Class (This Page)** Unclassified

**21. No. of Pages** 79

**22. Price**

(See ANSI–Z39.18)

*See Instructions on Reverse*

**OPTIONAL FORM 272 (4-77)**
**(Formerly NTIS-35)**
**Department of Commerce**

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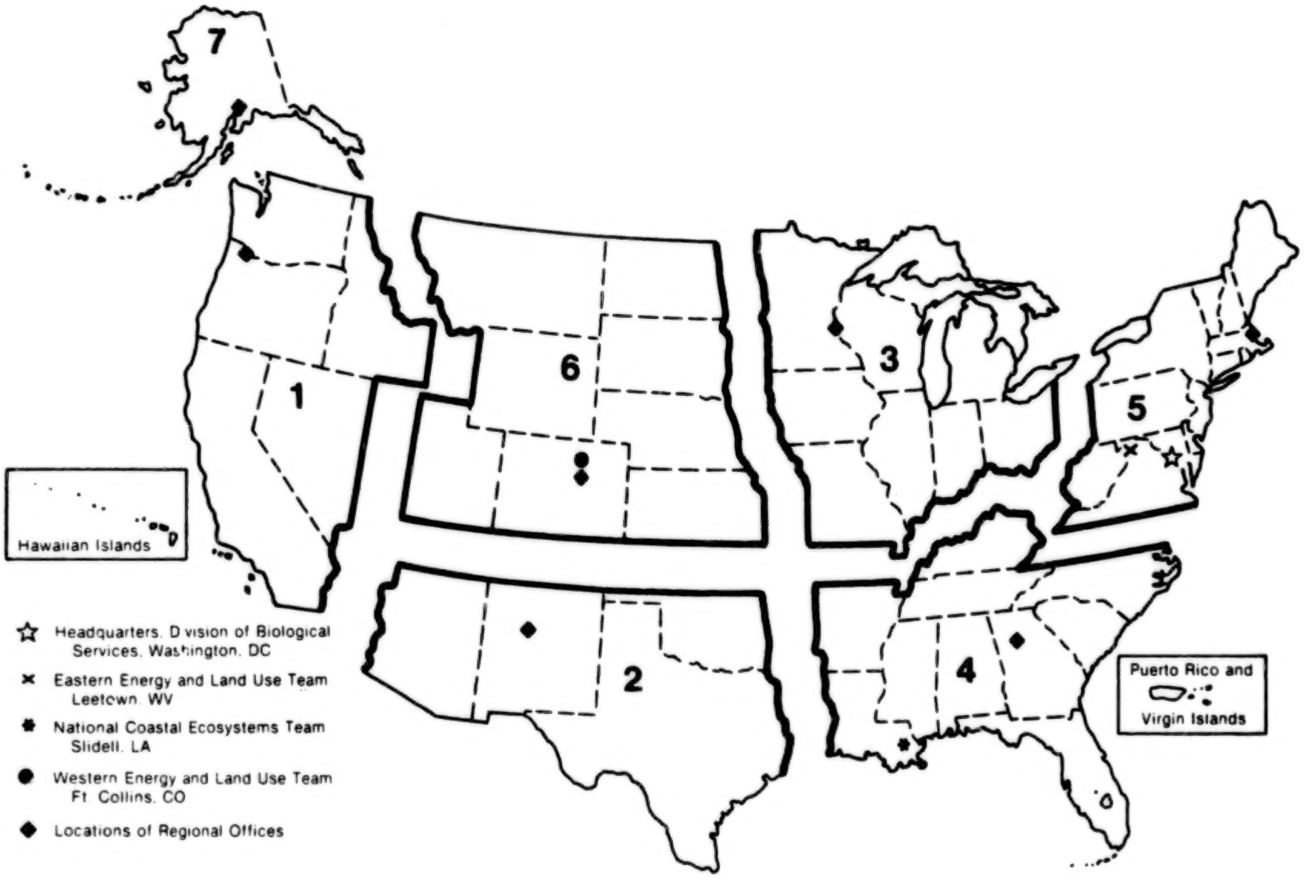
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Hawaiian Islands
Puerto Rico and Virgin Islands
☆ Headquarters, Division of Biological Services, Washington, DC
× Eastern Energy and Land Use Team Leetown, WV
✱ National Coastal Ecosystems Team Slidell, LA
● Western Energy and Land Use Team Ft. Collins, CO
◆ Locations of Regional Offices

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Regional Director
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500 N.E. Multnomah Street
Portland, Oregon 97232

**REGION 2**
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Albuquerque, New Mexico 87103

**REGION 3**
Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

**REGION 4**
Regional Director
U.S. Fish and Wildlife Service
Richard B. Russell Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

**REGION 5**
Regional Director
U.S. Fish and Wildlife Service
One Gateway Center
Newton Corner, Massachusetts 02158

**REGION 6**
Regional Director
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225

**REGION 7**
Regional Director
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503

March 3 1849

# DEPARTMENT OF THE INTERIOR

## U.S. FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.